Bihar Urban Infrastructure Development Corporation Ltd.
(A Govt. Of Bihar Undertaking)

Bid Document
For

Construction, Erection, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

September, 2020

VOLUME - I

IPRD_PR_007170/20-21
Size: 160.05

Govt. of Bihar

Bihar Urban Infrastructure Development Corporation Ltd.

A Government of Bihar Undertaking

NOTICE INVITING TENDER

for

Construction, Erection, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

NIT. No- BUIDCo/Yo-1875/20-178

(Through e-procurement mode only – www.eproc.bihar.gov.in

1. Bihar Urban Infrastructure Development Corporation Limited (BUIDCo) invites bids from eligible experienced Firms/Contractors/Agencies/Bidders registered in appropriate category in any government organization /PSUs for execution of works as given below :-

S. No	Name of work	Estimated Cost	Bid Processing fees Beltron)	Bid Document Cost	Bid Security (EMD)	Contract Duration
1.	Construction, Erection, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.	Rs. 312.16 Crore	Rs. 17,700.00	Rs. 1,00,000.00	Rs. 3.23 Crore	8 Months

2. Date of downloading of bid document : From **26-09-2020 to 27-10-2020** up to 12:00PM Through website www.eproc.bihar.gov.in
3a. Place & Date of Pre-bid meeting : Date **05-10-2020** Time 03:00PM.; Office- Near RajapurPul, West Boring Canal Road, Patna-80000
3b. Last Date of Receiving of queries : Date **07-10-2020** upto 5.00 PM on email id- mdbuidco@gmail.com
4. Last date and time for uploading of bids : Date **28-10-2020** up to 03:00PM Through website www.eproc.bihar.gov.in
5. Last Date and time for Submission of hard copy of bidDate : **29-10-2020** up to 03:00PM
6. Time and date of opening technical bids : Date **29-10-2020** Time 04:00PM
7. Time and date of opening of financial bids : To be communicated later on
8. Place of opening of bid : Through website www.eproc.bihar.gov.in
9. Period of bids validity : 120 days
10. Officer inviting bids : Chief Engineer, Design. Planning & Monitoring, BUIDCO
11. The detailed NIT can be obtained through website www.eproc.bihar.gov.in and www.buidco.in

विस्तृत जानकारी के लिए **state.bihar.gov.in/prdbihar** पर संम्पर्क करें

Chief Engineer,
Design, Planning & Monitoring,
Urban Development & Housing Department,Patna

Bihar Urban Infrastructure Development Corporation, Near RajapurPul, West Boring Canal Road, Patna-800001 (Tel: 0612-2558412,Email: mdbuidco@gmail.com)

PR-07170 (Ni Ni) 2020-21

नोवल कोरोना के संबंध में विस्तृत जानकारी एवं सहयोग हेतु 24X7 Toll Free No.: **104** पर संपर्क कर सकते हैं।

Bihar Urban Infrastructure Development Corporation Ltd.

A Government of Bihar Undertaking

NOTICE INVITING TENDER

for

STORM WATER DRAINAGE PUMPING STATIONS

NIT. No- BUIDCo/Yo-1875/20-178 | ***Date: 18-09-2020***

(Through e-procurement mode only – www.eproc.bihar.gov.in)

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9. Period of bids validity : 120 days

10. Officer inviting bids : Chief Engineer, Design. Planning & Monitoring, BUIDCO

11. For participating in E – tendering process, the contractor shall have to get themselves registered to get user ID, Password and Digital signature. This will enable them to access the website www.eproc.bihar.gov.in and download/participate in E – tender. All tender queries related to this tender shall be communicated at cebuidco@gmail.com

12. (i) Bid processing fees to be paid through online mode i.e. Internet payment getaway (Credit/Debit Card), Net Banking, NEFT/RTGS.
(ii) Bids along with necessary online payments must be submitted through e-procurement portal www.eproc.bihar.gov.in before the date & time specified in the NIT. The department does not take any responsibility for the delay/Non availability of internet connection, Network Traffic/Holidays or any other reasons".

13. The tender documents can be obtained through website www.eproc.bihar.gov.in

14. Bid document cost should be paid by draft of any scheduled banks payable in favour of Managing Director, Bihar Urban Infrastructure Development Corporation Ltd, Original Bank Draft will have to be submitted in the office of Managing Director, Bihar Urban Infrastructure Development Corporation Ltd, Near Rajapur Pul, West Boring Canal Road, Patna-800001 **on or before 03:00 PM on 29-10-2020** failing which the tender will be rejected.

15. Earnest Money should be in the form of Bank Guarantee of any scheduled banks payable in favour of Managing Director, Bihar Urban Infrastructure Development Corporation Ltd, **on or before 03:00 PM on 29-10-2020** failing which the tender will be rejected. The Estimated Cost may increase or decrease.

16. All the information/corrigendum/addendum related to the project shall be published on the website www.eproc.bihar.gov.in and www.buidco.in . The authority shall have the right to reject the bid partially or fully without assigning any reason what so ever.
For any information department help line No. 18003456109 may be used

18. Estimate amount may vary. So EMD will be deposited as per Technical Sheet uploaded on the website www.eproc.bihar.gov.in

19. Further details of works can be obtained from the office of Chief Engineer, Design. Planning & Monitoring For clarification, regarding the E –tendering process, please contact e-procurement, Helpdesk, first Floor, M/22, Bank of India Building, Road No-25, Sri Krishna Nagar, Patna – 800 001, Telephone no. 0612-2523006, Mobile No –07542028164.

Sd/-
Chief Engineer,
Design, Planning & Monitoring,
BUIDCo, Patna

DISCLAIMER

The information contained in this Request for Proposal ("RFP") document or subsequently provided to bidders, verbally or in documentary or any other form by or on behalf of the Bihar Urban Infrastructure Development Corporation Ltd., (here forth referred to as Authority in this document) or any of its employees or advisers, is provided to bidders on the terms and conditions set out in this RFP and such other terms and conditions subject to which such information is provided.

This RFP is not an agreement and is not an invitation by the Employer to the prospective Consultants or any other person. The purpose of this RFP is to provide interested bidders with information that may be useful to them in the formulation of their Proposals pursuant to this RFP. This RFP includes statements, which reflect various assumptions and assessments arrived at by the Employer in relation to the Contractor. Such assumptions, assessments and statements do not purport to contain all the information that each bidder may require. This RFP may not be appropriate for all persons, and it is not possible for the Employer, its employees, or advisers to consider the objectives, technical expertise and particular needs of each party who reads or uses this RFP. The assumptions, assessments, statements and information contained in this RFP, may not be complete, accurate, adequate or correct. Each bidder should, therefore, conduct its own investigations and analysis and should check the accuracy, adequacy, correctness, reliability and completeness of the assumptions, assessments and information contained in this RFP and obtain independent advice from appropriate sources. Information provided in this RFP to the bidder is on a wide range of matters, some of which depends upon interpretation of law. The information given is not an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. The Employer accepts no responsibility for the accuracy or otherwise for any interpretation or opinion on the law expressed herein.

The Authority also accepts no liability of any nature whether resulting from negligence or otherwise however caused arising from reliance of any bidder upon the statements contained in this RFP. The Authority may in its absolute discretion, but without being under any obligation to do so, update, amend or supplement the information, assessment or assumption contained in this RFP. The issue of this RFP does not imply that the Employer is bound to select a bidder or to appoint the selected bidder, as the case may be, for the Contractor and the Authority reserves the right to reject all or any of the Proposals without assigning any reasons whatsoever regarded as a complete or authoritative statement of law. The Employer accepts no responsibility for the accuracy or otherwise for any interpretation or opinion on the law expressed herein.

The Authority and its employees and advisers make no representation or warranty and shall have no liability to any person including any bidder under any law, statute, rules or regulations or tort, principles of restitution or unjust enrichment or otherwise for any loss, damages, cost or expense which may arise from or be incurred or suffered on account of anything contained in this RFP or

otherwise, including the accuracy, adequacy, correctness, reliability or completeness of the RFP and any assessment, assumption, statement or information contained therein or deemed to form part of this RFP or arising in any way in there.

The bidder shall bear all its costs associated with or relating to the preparation and submission of its Proposal including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by the Authority or any other costs incurred in connection with or relating to its Proposal.

All such costs and expenses will remain with the bidder and the Authority shall not be liable in any manner whatsoever for the same or for any other costs or other expenses incurred by a bidder in preparation or submission of the Proposal, regardless of the conduct or outcome of the Selection Process.

SECTION 1
INSTRUCTION TO BIDDERS
(ITB)

Section 1: Instructions to Bidders

Table of Clauses

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 NIT. The bidders may submit bids for any one group or all groups of the works detailed in the table given in NIT.

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.

1.4 Regarding PERCENTAGE RATE OR ITEM RATE, tender shall be as per Appendix to ITB and accordingly the non-relevant sections of this document must be crossed.

2. Sources of Funds

2.1 The expenditure on this project will be met as decided by the Competent Authority.

3 Eligible Bidders

3.1 This *Invitation for Bids* is open to all 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; Engineer-in-Charge or any other entity that has prepared the design, specifications, and other documents for the Project or being proposed as Project Director for the Contract or involved in supervision of the contract. A firm that has been engaged by BUIDCo to provide consulting services for the preparation or supervision of the works, and any of its affiliates shall not be eligible to bid.

3.3 Bidders shall not be under a declaration of ineligibility for delay, failure or corrupt and fraudulent practices by any of the State Govt. or Central Govt. or Public Undertaking or any Autonomous Body.

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 indicating mile stones to complete the project on time.

4.2 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) Proposals, if any, for sub-contracting of elements of work, costing more than 10% of the bid amount.

(iv) Power of attorney, if any.

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 or evidence of arrangement; of possessing them on hire/ lease/ buying as defined therein;

(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 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 dispute amount;

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

(l) the proposed methodology and programme 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.

4.4 Eligibility for Joint Venture: Bids from Joint ventures are acceptable for projects costing Rs. 10 crores or more. Eligibility for Joint Venture will be as per Road Construction department, Government of Bihar, Letter no. 02/2010-8131 (S) w dated 24-07-2012.

4.5 A.To qualify for award of the contract, each bidder in its name should have in the last five years as referred to in Appendix :-

(a) Achieved in any one year a minimum annual financial turnover (in all classes of civil engineering construction works only) volume of construction of at least the amount equal to the 50% (fifty percent) estimated cost of works for which bid has been invited. The turnover will be indexed at the rate of 8% for a year.

(b) Satisfactorily completed as a prime contractor (or as a nominated subcontractor, where the subcontract involved execution of all main items of work described in the bid document, provided further that all other qualification criteria are satisfied) similar work i.e. experience in the design, construction, supply, installation, testing and commissioning of wastewater /storm water / water pumping station in India including Electrical and Electro-Mechanical Works as follows:- One similar completed work costing not less then amount equal to 80% (276.91 Crore) of the estimated cost or two similar completed work costing not less than amount equal to 60%

(207.68 Crore) of the estimated cost or completed three similar completed works costing not less than amount equal to 40% (138.46 Crore) of the estimated cost

Relevant experience in design, construction, supply, installation, testing and commissioning satisfactorily of at least one wastewater /storm water / water pumping station work with minimum 80% (1304 MLD) capacity having depth of 12m along with MS pipeline of minimum 2250 mm dia and 3250m length of rising main.

OR

Relevant experience in design, construction, supply, installation, testing and commissioning satisfactorily of at least two wastewater /storm water / water pumping station work each work with minimum 60% (1000 MLD) capacity having depth of 9m along with MS pipeline of minimum 1700 mm dia and 2437m length of rising main.

OR

Relevant experience in design, construction, supply, installation, testing and commissioning satisfactorily of at least three wastewater /storm water / water pumping station work each work with minimum 40% (670 MLD) capacity having depth of 6m along with MS pipeline of minimum 1200 mm dia and 1625m length of rising main.

Supply, erection, testing and commissioning pump of capacity minimum 175 to 655 hp

(c) Executed in a year during the last 5 years the minimum quantities of the following items of work as indicated in Appendix.

i. Earth Work = 147380 cum

ii. Cement concrete (including PCC and RCC) = 54484 cum

(d) Deleted

(e) Deleted

B. Each bidder should further demonstrate:

(a) Availability (either owned or leased or by procurement against mobilization advances) of the following key and critical equipment for this work:

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 Annexure-I.

Availability of the testing equipment required for establishing field laboratory to perform mandatory tests e.g. those stated in Appendix to ITB.

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 (detailed) as stated in clause 4.3(i) above to allow BUIDCo 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.

(b) Availability for this work of personnel with adequate experience as required; as per Annexure-II.

(c) Liquid assets and/or availability of credit facilities of no less than amount indicated in Appendix to ITB

(Credit lines/letter of credit/certificates from Banks for meeting the funds requirement etc.- usually the equivalent of the estimated cash flow for 3 months in peak construction period.)

C. To qualify for a group of contracts made up of this and other contracts for which bids are invited in the IFB, the bidder must demonstrate having experience and resources sufficient to meet the aggregate of the qualifying criteria for the individual groups.

4.6 Sub-contractors' experience and resources shall not be taken into account in determining the bidder's compliance with the qualifying criteria.

4.7 Bidders who meet the minimum qualification criteria will be qualified only if their available bid capacity is more than the total bid value. The available bid capacity will be calculated as under:

Assessed Available Bid capacity = (A*N*3 – B)

Where

A = Maximum value of civil engineering works executed in any one year during the last five years (updated to the price level of the year indicated in Appendix) taking into account the completed as well as works in progress.

N = Number of years prescribed for completion of the works for which bids are invited (consider 1.5 for calculation).

B = Value (updated to the price level of the year indicated in Appendix) of existing commitments and on-going works to be completed during the next 1.0 Years (period of completion of the works for which bids are invited)

Note : *The statements showing the value of existing commitments and on-going works as well as the stipulated period of completion remaining for each of the works listed should be countersigned by the Engineer in charge, not below the rank of an Executive Engineer or equivalent.*

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

- made misleading or false representations in the forms, statements and attachments submitted in proof of the qualification requirements; and/or
- have record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays 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 any work or one package or group. 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 BUIDCo will in no case be responsible and liable for those costs.

In case of cancellation of tender, cost of bidding document will be charged each time.

7. Site Visit

7.1 The Bidder, at the Bidder's own responsibility and risk must visit and examine the Site of Works and its surroundings 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.

7.2. Tender documents are not transferable.

B.BIDDING DOCUMENTS

8. Content of Bidding Documents

8.1 The set of bidding documents comprises the documents listed below and addendum issued in accordance with Clause 10;

Section	Particulars	Volume No.
	Notice Inviting Tender	**I**
	Corrigendum (If any)	
1	**Instructions to Bidders**	
2	**Qualifications of Bidders**	
3	**Conditions of Contracts**	
4	**Contract Data**	
5	**Special condition of Contract**	**II**
6	**Technical Specifications**	**III**
7	**Bill of Quantities**	
8	**Securities and other forms**	
9	**Drawings**	**IV**
10	**Documents to be furnished by bidder**	**V**

8.2 Bidders will have to download each of the volumes I, II, III and IV in compliance to section 2 and completed documents will be uploaded by him 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 25 hereof, bids which are not substantially responsive to the requirements of the Bid Documents shall be rejected.

9. **Clarification of Bid documents**

9.1 Pre-bid meeting

9.1.1 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 appendix.

9.1.2 The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.

9.1.3 The bidder is requested to submit any questions in writing or by fax or through E-Mail to reach BUIDCo not later than one week before the pre-bid meeting.

9.1.4 Minutes of the meeting, including the text of the questions raised (without identifying the source of enquiry) and the responses given will be transmitted without delay to all through eproc website. 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 BUIDCo exclusively through the issue of an Addendum pursuant to Clause 10 and not through the minutes of the pre-bid meeting. All bidders have to download any addendum from the website. 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, BUIDCo may modify the bidding documents by issuing addendum.

10.2 Any addendum thus issued shall be part of the bidding documents and shall be downloaded by all the bidders.

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

C. PREPARATION OF BIDS

11. Language of the Bid

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

12. Documents Comprising the Bid

12.1 The bid to be uploaded 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) Earnest money 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 4.2 of these instructions

(v) Undertaking that the bid shall remain valid for the period specified in Clause 15.1

(vi) An affidavit affirming the information be has furnished in the bidding document is correct to the best of his knowledge and belief.

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 Each part will be separately prepared and uploaded on website www.eproc.bihar.gov.in in case of e-bidding.

12.3 Following documents, which are not submitted with the bid, will be deemed to be part of the bid**.**

Section	Particulars	Volume No.
1	**Instructions to Bidders**	**Volume I**
2	**Qualifications of Bidders**	**Volume I**
3	**Conditions of Contract**	**Volume I**
4	**Contract Data**	**Volume I**
5	**Special Conditions of Contract**	**Volume II**
6	**Specifications**	**Volume III**
9	**Drawings**	**Volume IV**

13.Bid Prices

13.1 The contractor shall bid for the whole work as described in Sub-Clause 1.1 based on the priced Bill of Quantities submitted by the Bidder.

13.1.1 The bidder shall adopt the percentage rate method or item rate method as specified in the appendix to ITB; only the same option is allowed to all the bidders. Percentage rate method requires the bidder to quote a percentage above/below/ at par of the schedule of rates specified in the appendix to ITB. Item

rate method requires to quote 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 figure and words. Items for which no rate or price is entered by the bidder will not be paid for by the Employer when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities. Corrections, if any, shall be made by crossing out, initialing, dating and rewriting.

13.1.2 All duties, taxes, and other levies 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.

13.2 The rates and prices quoted by the bidder are subject to adjustment during the performance of the Contract in accordance with the provisions clause 10CA & 10CC clause Conditions of Contract.

13.3 The rate should include the cost of all seen and unseen expenditure. No claim, whatsoever, will be entertained due to non-inclusion of any such event necessary for the completion of the item of work.

14. Currencies of Bid and Payment

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

15. Bid Validity

15.1 Bids shall remain valid for a period not less than 120 days after the deadline date for bid submission specified in Clause 20.A bid valid for a shorter period shall be rejected by the Employer as non-responsive. In case of discrepancy in bid validity period between that given in the undertaking pursuant to Clause 12.1 (v) and the Form of Bid submitted by the bidder, the latter shall be deemed to stand corrected in accordance with the former and the bidder has to provide for any additional security that is required.

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 additional period. The request and the bidders' responses shall be made in writing or by cable. 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.

16. Earnest Money

16.1 The Bidder shall furnish, as part of his Bid, a Bid security in the amount as per NIT for this particular work. This bid security shall be in favor of **MD BUIDCo**.

a. Demand Draft of any scheduled Indian Bank.

b. Unconditional bank guarantee from any scheduled Indian bank issued within the state in the format given in Vol. III (If issued from any bank outside state will be converted to any bank within the state before executing the agreement).

16.2 Unconditional 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.

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 Earnest money 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 Earnest money of the successful bidder will be discharged when the bidder has signed the Agreement and furnished the required Performance Security.

16.6 The Earnest money 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, pursuant to Clause 26; or

(c) in the case of a successful Bidder, if the Bidder fails within the specified time limit to

(i) sign the Agreement; or

(ii) Furnish the required Performance Security.

17. Alternative Proposals by Bidder

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 offer or alternative offers will not be considered further in the process of tender evaluation.

17.2 Conditional tender will be rejected forthwith.

18. Format and Signing of Bid

18.1 The Bidder shall upload Technical bid and financial bid comprising of the documents as described in clause 12 of ITB at the eproc site(www.eproc.bihar.gov.in)

18.2 The Bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the Bidder, pursuant to Sub-Clause 4.3. All pages of the bid where entries or amendments have been made shall be initialed by the person or persons signing the bid and a certificate of corrections must be given by BUIDCo.

18.3 The Bid shall contain no alterations or additions, except those to comply with instructions issued by BUIDCo, or as necessary to correct errors made by the bidder, in which case such corrections shall be initialed by the person or persons signing the bid.

D.SUBMISSION OF BIDS

(only on website: www.eproc.bihar.gov.in)

(Sl.No. 19 To 21.1, shall be done through e-tendering Process)

19. Sealing and Marking of Bids

19.1 The bidder shall download the bid document from the site website: www.eproc.bihar.gov.in and upload the scanned copy of required documents together with filled up documents on the website.: www.eproc.bihar.gov.in

The contents of Technical and Financial Bids will be as specified in clause 12.1

19.2 The employer or service provider is not responsible for any failure such as a bad internet connection or power failure outside of their control. The bidder is responsible to ensure they have sufficient time to submit an electronic bid prior to closing including the payment and receipt of any fees including EMD.

19.3 The bidder have to submit original instruments of EMD and cost of BOQ in a envelope clearly marked the name of bidder, purpose and shall be addressed to the employer.

19.4 Deleted.

20. Deadline for Submission of the Bids

20.1 Complete Bids (including Technical and Financial) must be uploaded at www.eproc.bihar.gov.in 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 rights and obligations 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 Deleted.

E. BID OPENING AND EVALUATION

(Only on website: www.eproc.bihar.gov.in)

(Sl.No. 22 To 27.5, All Process shall be done through e-tendering Process)

22. Bid Opening

22.1 BUIDCo or their authorized representative will open all the Bids submitted on **www.eproc.bihar.gov.in** at the time and date specified in Appendix in the manner specified in Clause 20 and 22.3.

22.2 Deleted.

22.3 The "Technical Bid" shall be opened on the website **www.eproc.bihar.gov.in**. The amount, form and validity of the Earnest money furnished with each bid will be verified. If the bid security furnished does not conform to the amount and validity period as specified in the Invitation for Bid (ref. Column 6), and has not been furnished in the form specified in Clause 16, the technical bid will not be opened.

22.4 (i) Subject to confirmation of the bid security by the issuing Bank, the bids accompanied with valid 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) After receipt of confirmation of the bid security, the bidder will be asked in writing (usually within 10 days of opening of the Technical Bid) to clarify or modify his technical bid, if necessary, with respect to any rectifiable defects.

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

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

22.5 The Financial bids of only those bidders will be opened on the website **www.eproc.bihar.gov.in**, who qualifies in the technical evaluation. The remaining bids will not be opened. The responsive Bidders' names, the Bid prices, the total amount of each bid, any discounts, Bid Modifications and withdrawals, and such other details as BUIDCo may consider appropriate, will be announced by BUIDCo at the opening. Any Bid price or discount, which is not read out and recorded will not be taken into account in Bid Evaluation.

22.6 In case bids are invited in more than one package, the order for opening of the "Financial Bid" shall be that in which they appear in the "Invitation For Bid".

22.7 BUIDCo shall prepare minutes of the Bid opening, including the information disclosed to those present in accordance with Sub-Clause 22.5

23. Process to be Confidential

23.1 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 a Bidder to influence BUIDCo's processing of Bids or award decisions may result in the rejection of his Bid.

24. Clarification of Financial Bids

24.1 To assist in the examination, evaluation and comparison of Bids, BUIDCo 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 sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by BUIDCo in the evaluation of the Bids in accordance with Clause 26.

24.2 Subject to sub-clause 24.1, no Bidder shall contact BUIDCo on any matter relating to his bid from the time of the bid opening to the time the contract is awarded. If the Bidder wishes to bring additional information to the notice of BUIDCo, it should do so in writing.

24.3 Any effort by the Bidder to influence BUIDCo in BUIDCo's bid evaluation, bid comparison or contract award decisions may result in the rejection of the Bidders' bid.

25. Examination of Bids and Determination of Responsiveness

25.1 During detailed evaluation of "Technical Bids", BUIDCo 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 documents. 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.

25.2 A substantially responsive "Financial Bid" is one which conforms to all the terms, conditions, and specifications of the 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, BUIDCo'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.

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

26. Correction of Errors

26.1 "Financial Bids" determined to be substantially responsive will be checked by BUIDCo for any arithmetic errors. Errors will be corrected by BUIDCo 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 quality, the unit rate as quoted will govern.

26.2 The amount stated in the "Financial Bid" will be corrected by BUIDCo 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 Earnest money may be forfeited in accordance with Sub-Clause 16.6(b).

27. Evaluation and Comparison of Financial Bids

27.1 BUIDCo will evaluate and compare only the Bids determined to be substantially responsive in accordance with Sub-Clause 25.2.

27.2 In evaluating the Bids, BUIDCo 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 26; or

(b) making an appropriate adjustment for any other acceptable variations, deviations.

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

27.4 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, BUIDCo may require the Bidder to produce detailed price analysis for any or all items of the Bill of Quantities, to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analysis, BUIDCo may require that the amount of the performance security set forth in Clause 31 be increased at the expense of the successful Bidder to a level sufficient to protect BUIDCo against financial loss in the event of default of the successful Bidder under the Contract.

27.5 A bid, in the opinion of employee 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.

F. AWARD OF CONTRACT

28. Award Criteria

28.1 Subject to Clause 29, BUIDCo 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 on overall evaluation for both schedule A (Percentage Rate Method) & Schedule B (Item Rate Method); and

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

29. BUIDCo's Right to Accept any Bid and to Reject any or all Bids

Notwithstanding Clause 28, BUIDCo 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 in incurring any liability to the affected Bidder or Bidders or any obligation to inform the affected Bidder or Bidders of the ground for BUIDCo's action.

30. Notification of Award and Signing of Agreement

30.1 The Bidder whose Bid has been accepted will be notified of the award by BUIDCo prior to expiration of the Bid validity period by cable, telex or facsimile confirmed by registered letter. This letter (hereinafter and in the *General Conditions of Contract* called the "Letter of Acceptance") will state the sum that BUIDCo 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").

30.2 The notification of award will constitute the formation of the Contract, subject only to the furnishing of the performance security in accordance with the provisions of Clause 31.

30.3 The Agreement will incorporate all agreements between BUIDCo and the successful Bidder. It will be signed by BUIDCo and the successful Bidder, after the performance security is furnished.

31. Performance Security

31.1 Within 15 (Fifteen) days of receipt of the Letter of Acceptance, the successful Bidder shall deliver to BUIDCo a Performance Security in any of the forms given below for an amount equivalent 2% of the Contract price plus additional security for unbalanced Bids in accordance with the Clause 27.4 of ITB and the provisions of Bihar Financial Rules.

31.2 If the performance security is provided by the successful Bidder in the form of Bank Guarantee, it shall be issued either (a) at the Bidder's option, by a Nationalized/ Scheduled Indian bank within state or (b) acceptable to BUIDCo.

31.3 Failure of the successful Bidder to comply with the requirements of Sub-Clause 31.1 shall constitute sufficient grounds for cancellation of the award and forfeiture of the Bid Security.

32. Advance Payment and Security

32.1 BUIDCo will provide an Advance Payment on the Contract Price as stipulated in the General Conditions of Contract, subject to maximum amount, as stated in the Contract Data.

33. Corrupt or Fraudulent Practices

33.1 BUIDCo will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question and will declare the firm ineligible, either indefinitely or for a stated period of time, to be awarded a contract with BUIDCoor any other agencies, if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for the contractor, or in execution.

33.2 Furthermore, Bidders shall be aware of the provision stated in Sub-Clause and Sub-Clause 14 of the General Conditions of Contract.

G. APPENDIX to ITB

Clause Reference with respect to Section-I.

1. Name of the Employer: Managing Director, BUIDCo. **[Cl. 1.1]**

2. The last five years means for this tender

2015– 2016

2016– 2017

2017- 2018

2018 - 2019

2019 - 2020

3. The required annual financial turn over amount is Rs. 173.07 Crore (50% of Tender Cost) **[Cl. 4.5A(a)]**

4. Satisfactorily completed as a prime contractor (or as a nominated subcontractor, where the subcontract involved execution of all main items of work described in the bid document, provided further that all other qualification criteria are satisfied) similar work i.e. experience in the design, construction, supply, installation, testing and commissioning of wastewater /storm water / water pumping station in India including Electrical and Electro-Mechanical Works as follows:- One similar completed work costing not less then amount equal to 80% (276.91 Crore) of the estimated cost or two similar completed work costing not less than amount equal to 60% (207.68 Crore) of the estimated cost or completed three similar completed works costing not less than amount equal to 40% (138.46 Crore) of the estimated cost **[Cl. 4.5A(b)]**

Relevant experience in design, construction, supply, installation, testing and commissioning satisfactorily of at least one wastewater /storm water / water pumping station work with minimum 80% (1304 MLD) capacity having depth of 12m along with MS pipeline of minimum 2250 mm dia and 3250m length of rising main.

OR

Relevant experience in design, construction, supply, installation, testing and commissioning satisfactorily of at least two wastewater /storm water / water pumping station work each work with minimum 60% (1000 MLD) capacity having depth of 9m along with MS pipeline of minimum 1700 mm dia and 2437m length of rising main. **[Cl. 4.5A(c)]**

OR

Relevant experience in design, construction, supply, installation, testing and commissioning satisfactorily of at least three wastewater /storm water / water pumping station work each work with minimum 40% (670 MLD) capacity having depth of 6m along with MS pipeline of minimum 1200 mm dia and 1625m length of rising main.

Supply, erection, testing and commissioning pump of capacity minimum 175 to 655 hp

5 (f) Executed in a year during the last 5 years the minimum quantities of the following items of work as indicated in Appendix.

Earth Work = 147380 cum

Cement concrete (including PCC and RCC) = 54484 cum

An Escalation rate of 10% p.a. can be applied to arrive at current year value.

6. **Liquid assets and/or availability of credit facilities is 10% of Estimated Cost.** **[Cl. 4.5B(c)]**

7. **The Pre-bid meeting will take place at BUIDCo Office at 03:00 PM on Date 05-10-2020**

8. The technical bid will be opened at **04:00 PM** ***on 29-10-2020 through*** website **www.eproc.bihar.gov.in.**

9. **Address of the Employer** **[Cl. 4.5(a)]**

Managing Director,

Bihar Urban Infrastructure Development Corporation Limited.

Near Rajapur Pul, West Boring Canal Road, Patna-800001
(Tel: 0612-2506213/2506109,Email: mdbuidco@gmail.com)

10. **Identification:** **[/cl. 19.2(b)]**

Bid for:

Construction, Erection, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

NIT No. – BUIDCo/Yo-1875/20- 178, Date: 18-09-2020

11. **Bids are to be submitted only in Item Rate Method**

12. **The bid should be submitted (Upload) latest by 28-10-2020 upto 03:00 PM *through website: www.eproc.bihar.gov.in only.*** **[Cl. 20.1(a)]**

13. The technical bid will be opened at 04:00 PM **on 29-10-2020** ***through*** website **www.eproc.bihar.gov.in.** **[Cl. 23.1]**

14. **The Bank Draft in favor of Managing Director, Bihar Urban Infrastructure Development Corporation Limited. Patna.** **[Cl. 34.1]**

15. **Escalation factors (for the cost of works executed and financial figure to a common base value for works completed)**

Year before	Multiply Factor
One	1.10
Two	1.21
Three	1.33
Four	1.46
Five	1.61

Annexure -1

[Reference Cl. 4.4(B) (a)]

Details of construction and equipment/indicative likely to be used in carrying out the work

[Reference Cl. 4.5 (B) (a)]

S. No	Type of Equipment (Leased or Owned)	Minimum No. of Equipment Required
1	Excavators	2
2	Batching Plant	1
3	Well-equipped Laboratory facility for Construction quality test (i.e., Cube Testing Machine, Sieves, Ovens, Cube Moulds, Slump test Mould etc.,) as per SP -20- 2002 (BIHAR., PWD)	1
4	Total Station	2
5.	Front end Loader	5
6.	Smooth Wheeled Roller	2
7.	Bar Cutting Machine	22
8.	Welding Machine	22
9.	Vibrator (Needle)	50
10.	Transit Mixer with pumping arrangement	22
11.	Steel Plate/Ply shuttering/ Props with fittings etc.,	For 3000 Sqm
12.	Dewatering Pumps 10HP	22
14	Dumpers	22

ANNEXURE – II

List of Key Personnel to be deployed on Contract Work (Indicative)

[Reference Cl. 4.4(B) (b)]

Sl. No.	Personnel	Qualification	No. of Person
1	Project Manager/ Team Leader	B.E/ B.Tech in Civil Engineering with 15 Years Exp. (5 years as Project Manager) in Water Supply, Sewerage, Drainage Works including Pumping Stations and STPs	01
2	Dy Project Manager/ Dy Team Leader	B.E/ B.Tech in Civil Engineering with 10 Years Exp. (3 years as Dy Project Manager/ Dy Team Leader) in Water Supply, Sewerage, Drainage Works including Pumping Stations and STPs	03
3	Site Engineer (Civil)	B.E/ B.Tech in Civil Engineering with 7 Years Exp. (including 5 years in Water Supply, Drainage, Sewerage works) or Diploma Civil with 10 Years Exp. (including 05 years in Water Supply, Drainage, Sewerage works)	11
4	Electro Mechanical Engineer	B.E. Electrical Engg./ Mechanical Engineering with 10 years Exp. In Installation and Commissioning of Pumps and Electro-Mechanical Works related to Water Supply,	05

		Sewerage, Drainage works.	
5.	Quality Control Engineer	B.E/ B.Tech in Civil Engineering with 5 years' Experience in Quality Control works or Diploma in Civil Engineering with 8 Years experience	04
6	Supervisor	Diploma in Civil Engineering with 5 years' Experience in construction works along with quality control works.	22

SECTION 2

QUALIFICATION INFORMARION

(To be filled in by Bidder)

QUALIFICATION INFORMATION

The information to be filled in by the Bidder in the following pages will be used for purposes of post qualification as provided for in Clause 4 of the Instructions 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 construction 20_____20_____
work performed in the last seven years** 20_____20_____
(in Rs. Million) 20_____20_____

1.3.1 Work performed 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 satisfied (in the same name) on works of a similar nature over the last five years.**

Project Name	Name of the Employer*	Description of work	Contract No.	Value of Contract (Rs. In Crores)	Date of issue of work order	Stipulated period of completion	Actual date of completion *	Remarks 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.*
β *Attach certificate from Chartered Accountant*

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 satisfied (in the same name and style) in the last seven years :**

Year	Name of the work	Name of the Employer*	Quantity of work performed (cum) @ Remarks						
			Cement Concrete (including RCC & PCC)	Masonry	Earth works	WBM	WMM	Bituminous Work	Remarks* (indicate contract Ref)
20__20__ 20__20__ 20__20__ 20__20__ 20__20__									

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 of Contract (Rs Cr)	Stipulated Period of Completion	Value of works* remaining to be completed (Rs Cr)	Anticipated date of completion
1	2	3	4	5	6	7	8

** Attach certificate(s) from the Engineer(s)-in-Charge*
@ The item of work for which data is requested should tally with that specified in ITB clause 4.5A (c)
*** Immediately preceding the financial year in which bids are received.*
 # Delete, if prequalification has been carried out.

(B) Works for which bids already submitted :

Description of works	Place & State	Name & Address of Employer	Estimated value of works (Rs Cr)	Stipulated period of completion	Date when decision is expected	Remarks, if any
1	2	3	4	5	6	7

1.4 Availability of key items of Contractor's Equipment essential for carrying out the Works [Ref. Clause 4.5(B)(a)]. The Bidder should list all the information requested below. Refer also to Sub Clause 4.3 (d) of the Instruction to Bidders.

Description of works	Requirement		Availability proposals			Remarks (from whom to be purchased)
	No.	Capacity	Owned/Leased to be procured	Nos./Capacity	Age/ Condition	
1	2	3	4	5	6	7

1.6 Qualifications and experience of key personnel required for administration and execution of the Contract [Ref. Clause 4.5(B)(b)]. Attach biographical data. Refer also to Sub Clause 4.3 (e) of instructions to Bidders and Sub Clause 9.1 of the Conditions of Contract.

Position	Name	Qualification	Year of Experience (General)	Years of experience in the proposed position
Project Manager				

Etc.				

1.7 Proposed sub-contracts and firms involved. [Refer ITB Clause 4.3(k)]

Sanction of the works	Value of Sub-contract	Sub-contractor (Name & Address)	Experience in similar work
1	2	3	4

Attach copies of certificates on possession of valid license for executing water supply/ sanitary work/ building electrification works [Reference Clause 4.5(d) & Clause 4.5(e)]

*1.8 Financial reports for the last seven years: balance sheets, profit and loss statements, auditors' reports (in case of companies/corporation), 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 copies of support documents.

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

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 instructions to Bidders. (Name of Consultant engaged for project preparation 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 & 4.3(1)]

1.14 Programme

1.15 Quality Assurance Programme

2. Additional Requirements

2.1 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

_____

** *Fill the Name of Consultant.*

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

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

(CLAUSE 4.2 (i) 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 to the above contract during the contract period.

_____

(Signature)

Name of Bank

Senior Bank Manager

Address of the Bank

AFFIDAVIT

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_____ _____ has been blacklisted nor has abandoned any work in any government department, 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 authorizes and request(s) any bank, person, firm or corporation to furnish pertinent information deemed necessary and requested by BUIDCo to verify this statement or regarding my (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 BUIDCo.**

_____

(Signed by an Authorized Officer of the Firm)

_____

Title of Officer

_____

Name of Firm

_____

DATE

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 Authorised Officer of the Firm)

_____

Title of Officer

_____

Name of Firm

_____

DATE

SECTION 3

GENERAL CONDITIONS OF CONTRACT

Table of Contents

Finishing Control

Quality Control

Other Condition & Control

GENERAL GUIDELINES

1. This book of "General Conditions of Contract" is applicable to both types of tenders i.e. "Percentage rate tenders" and "Item rate tenders". Accordingly alternative provisions for conditions Nos. 4, The appropriate alternatives will be applicable in specific cases depending on whether this is used for percentage rate tender or item rate tender Schedules A to F, special conditions/ specifications and drawing only will be issued to intending bidders. The standard form shall form part of the agreement to be drawn and signed by both parties after acceptance of tender.

3. All blanks are confined to Notice Inviting Tender and Schedules A to F.

4. Authority approving the Notice Inviting Tender (NIT) shall fill up all the blanks in 6 and in Schedules B to F before issue of Tender Papers.

5. The intending bidders will quote their rates in Schedule A.

6. The Performa for registers and Schedules A to F are only for information and guidance. These are not to be filled in the Standard Form. The Schedules with all blanks, duly filled shall be separately issued to all intending tenderers.

Bihar Urban Infrastructure Development Corporation Limited
(A Govt. Of Bihar Undertaking)

1. Tender on the behalf of Government of Bihar invites percentage rate For SOR Item and Item rate for Non SOR Item bids from the eligible and approved contractor registered with State other State &Central Government / PSU or any Agency of National or International repute for each of the following works.

District	Name of work	Estimated cost in Rs.	Earnest money in Rs.	Time allowed for completion	Last date and time for receipt of application for issue of tender forms	Time and date of opening of tender	Place of sale and submission of tender
1	2	3	4	5	6	7	8
As per NIT							www.eproc.bihar.gov.in *only*

The bidders who download the bidding documents from the internet site www.eproc.bihar.gov.in

would have to pay the cost of bid documents and submit it in a separate envelope marked cost of bidding document downloaded from internet.

Criteria of eligibility for issue of tender document

1.1 Issue of Tender to any Contractor registered with Central Government / any State Government or any PSU or an agency of international or national repute may be submitted without the registration. However, registration with the concerned works department will be essential after issue of L.O.A.

Following documents duly attested by gazetted officer and photocopied are required at the time of submission of bid (In case of other State PWD/ CPWD/ any PSU eligible contractors or Agencies of National/ International repute following documents (from a to c) have to be submitted after letter of acceptance).

(a) Registration paper (renewed) of appropriate class and deptt.

(b) Latest sales tax clearance/ sales tax registration in State of Bihar.

(c) Latest labour license (renewed) in State of Bihar.

(d) Power of attorney/ partnership deed/ MoU of private limited company.

(e) Bank Draft for B.O.Q. cost.

(f) Tools & plans ownership/ lease certificate required in aforesaid work duly verified from Project director / other State PWD / CPWD Contractor will provide definite proof from appropriate authority for tools & Plant and Undertaking to install it on works site after getting letter of acceptance.

2. Agreement shall be drawn with the successful tenderer on Agreement Form attached. Tenderer shall quote his rates as overall percentage above/below for SOR Items whereas for Non SOR items bidder should quote item wise rate. The amount of B.O.Q. as per various terms and conditions of the said form which will form part of the agreement.

3. The amount of Estimated Cost or B.O.Q. Cost of the work may vary.

4. The earnest money will be applicable on the sanction cost of B.O.Q. only.

5. The time allowed for carrying out the work will be from the same day after the date of written orders to commence the work or from the first date of handing over of the site, whichever is later, in accordance with the phasing, if any, indicated in the tender documents.

6. The site for the work is available.

OR

The site for the work shall be made available in parts as specified below :-

_____

_____

_____

7. Deleted

Tender documents consisting of plans, specifications, the schedule of quantities of the various classes of work to be done and the set of terms & conditions of contract to be complied with by the contractor whose tender may be accepted and other necessary documents can be seen at the site of the www.eproc.bihar.gov.in. Tender documents, including standard form, will be ***Downloaded*** from www.eproc.bihar.gov.in during the ***Dates*** specified in Appendix to ITB.

8. Original Draft of Cost of B.O.Q and Earnest Money in Prescribed form, which should always be placed in sealed envelope, with the name of work and due date written on the envelopes, will be received by the Managing Director /Chief General Manager BUIDCo

9. The Contractor shall be required to deposit an amount equal to 2% of the tendered value of the work as performance guarantee in the form as mentioned in Bihar Financial Rules. For works costing more than one Crore, bank guarantee is acceptable.

10. The description of the work is as follows: -

As per NIT

Copies of other drawings and documents pertaining to the works will be open for inspection by the tenderers at the office of the above-mentioned officer.

Tenderers are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their tenders as to the nature of the ground and bub-soil (so far as is practicable), the form and nature of the site, the means of access to the site the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their tender. A tenderer shall be deemed to have full knowledge of the site whether he inspects it or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed. The tenderer shall be responsible for arranging and maintaining at his own cost all materials, tool & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a tender by a tenderer implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and of conditions and rates at which stores, tools and plant, etc. will be issued to him by BUIDCo and local conditions and other factors having a bearing on the execution of the work.

11 Canvassing whether directly or indirectly, in connection with tenders is strictly prohibited and the tenders submitted by the contractors who resort to canvassing will be liable to rejection.

12 The competent authority on behalf of Governor of Bihar reserves to himself the right of accepting the whole or any part of the tender and the tenderer shall bound to perform the same at the rate quoted.

13 The contractor shall not be permitted to tender for works in the BUIDCo (responsible for award and execution of contracts) in which his near relative is posted as **Accountant** or as an officer in any capacity between the grades of C.E/S.E/EE/AE/JE (all inclusive). He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any **officer** in BUIDCo. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of **BUIDCo**.

14 No Engineer of Gazetted rank or other Gazetted officer employed in Engineering or Administrative duties in an Engineering Department of the Government of Bihar is allowed to work as a contractor for a period of two years after his retirement from Government service, without the previous permission of the Government of Bihar in writing. This contract is liable to be cancelled if either the contractor or any of his employee is found any time to be such a person who had not obtained the permission to the Government of Bihar as aforesaid before submission of the tender or engagement in the contractors service.

15 The tender for the works shall remain open for acceptance for a period of 120 days from the date of opening of tenders. If any tenderer withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the department, then the Government shall, without prejudice to any other right or remedy, be at liberty to forfeit **100%** of the said earnest money as aforesaid.

17. BUIDCo has right to cancel or postpone any work without given any notice or clarification.

18. BUIDCo may add or delete any of the condition required for execution of any work.

19. This Notice Inviting Tender shall form a part of the contract document. The successful tenderer / contractor, the **Competent Authority**, shall issue the letter of acceptance and will sign the contract within 15 days after submitting the performance guarantee.

Bihar Urban Infrastructure Development Corporation Limited
(A Govt. Of Bihar Undertaking)

STATE - BIHAR

Organization : BUIDCo

(A) Tender for the work of: -

The scope of work includes Construction, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

The Successful bidder has to build a complete and fully functioning Storm Water Drainage Pumping Stations with outfall pipeline to the designated disposal point in accordance with the Bid Documents. The scope of work shall include the following activities:

- Field survey and investigation with total station and GIS & Geo technical survey wherever required.
- Construction and Commissioning of all Civil Works required for Drainage Pumping Stations.
- Supply and Erection of Screens, Pumps and associated valves and all other Electromechanical Items required for the Drainage Pumping Stations.
- Carry out Trial Tests and Commissioning of the Pumping Station in Totality.
- Construction of outfall pipe / channel

The construction and commissioning shall be executed in compliance with international best practice and all relevant Indian legislation.

Following are the proposed Pumping Stations with location reference in Patna:

Name and Location of Proposed Drainage Pumping Stations

S. No	Name of DPS	Northing	Easting
1	Big Hospital	25°35'11.38"N	85°11'43.53"E
2	Khagaul - Danapur near Hitech Hospital	25°37'14.14"N	85° 2'24.51"E
3	Bakri Bazar	25°36'37.03"N	85°10'38.99"E
4	Karori chak	25°34'10.85"N	85° 5'20.95"E
5	Dasaratha	25°34'42.96"N	85° 7'27.38"E
6	Digha (Near Old Thana)	25°38'46.80"N	85° 4'52.00"E
7	Nandlal Chhapra	25°35'7.16"N	85°10'20.14"E

S. No	Name of DPS	Northing	Easting
8	Premkunj (Kamali Chowk)	25°34'28.40"N	85°14'3.28"E
9	Rajiv Nagar	25°37'19.42"N	85° 4'57.55"E
10	Beur Betaura Pul	25°33'53.16"N	85° 5'44.23"E
11	Isopur Brama Ashtan	25°33'19.47"N	85° 3'44.28"E
12	Gurudaur Nehru Path	25°37'40.08"N	85° 4'15.00"E
13	Khanpura	25°32'27.20"N	85°14'28.00"E
14	Barmutta	25°31'51.49"N	85°13'31.33"E
15	Patna Canal DPS @ Digha	25°39'1.36"N	85° 4'49.64"E
16	Sandalpur	25°36'1.30"N	85°11'32.89"E
17	Bahadurpur TV Tower	25°35'32.27"N	85°10'11.30"E
18	Saidapur NCC	25°36'38.30"N	85°10'8.76"E
19	Rampur	25°36'41.08"N	85°10'28.15"E
20	Congress Maidan	25°36'32.43"N	85° 9'10.68"E
21	RMRI	25°35'57.47"N	85°11'47.39"E
22	RK Avenue	25°36'39.80"N	85° 9'35.18"E

(i) To be submitted (Upload) by DATE **As per NIT**

(ii) To be opened at **DATE As per NIT *Through website.*** www.eproc.bihar.gov.in

T E N D E R

I/We have read and examined the notice inviting tender, schedule, A,B,C,D,E & F. Specifications applicable, Drawings & Designs, General Rules and Directions, Conditions of Contract, clauses of contract, Special conditions, Schedule of Rate & other documents and Rules referred to in the conditions of contract and all other contents in the tender document for the work.

I/We hereby tender for the execution of the work specified for the Governor of Bihar within the time specified in Schedule 'F', viz., schedule of quantities and in accordance in all in respects with the specifications, designs, drawings and instructions in writing referred to in Rule-1 of General Rules and Directions and in Clause 11 of the Conditions of contract and with such materials as are provided for, by, and in respect in accordance with, such conditions so far as applicable.

We agree to keep the tender open for one hundred twenty (120) days from the due date of submission thereof and not to make any modifications in its terms and conditions.

Bid cost(Non Refundable) and EMD for one or all groups as mentioned in NIT shall be submitted by the bidder. If I/We, fail to furnish the prescribed performance guarantee within prescribed period, I/we agree that the said Governor of Bihar or his successors in office shall without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money absolutely. Further, if/we fail to commence work as specified, I/we agree that Governor of Bihar or his successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and the performance guarantee absolutely, otherwise the said earnest money shall be retained by him towards security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to therein and to carry out such deviations as may be ordered, up to maximum of the percentage mentioned in Schedule 'F' and those in excess of that limit at the rates to be determined in accordance with the provision contained in Clause 12.2 and 12.3 of the tender form.

I/We hereby declare that I/We shall treat the tender documents drawings and other records connected with the work as secret/confidential documents and shall not communicate information/derived therefrom to any person other than a person to whom I/We am/are authorized to communicate the same or use the information in any manner prejudicial to the safety of the State.

Dated ..... Signature of Contractor
Postal Address

Witness :

Address :

Occupation :

A C C E P T A N C E

The above tender (as modified by you as provided in the letters mentioned hereunder) is accepted by me for and on behalf of the Governor of Bihar for a sum of Rs.....(Rupees.....)

The letters referred to below shall form part of this contract Agreement :-

a)

b)

c)

For & on behalf of the Governor of Bihar.

Signature .....

Dated .....

Bihar Urban Infrastructure Development Corporation Limited

(A Govt. of Bihar Undertaking)

General Rules & Directions

1. All work proposed for execution by contract will be notified in a form of invitation to tender pasted in public places and signed by the officer inviting tender or by publication in Newspapers and the internet as the case may be.

This form will state the work to be carried out, as well as the date for submitting and opening tenders and the time allowed for carrying out the work, also the amount of earnest money to be deposited with the tender, and the amount of the security deposit to be deposited by the successful tenderer and the percentage, if any, to be deducted from bills. Copies of the specifications, designs and drawings and any other documents required in connection with the work signed for the purpose of identification by the officer inviting tender shall also be open for inspection by the contractor at the office of officer inviting tender during office hours.

2. In the event of the tender being submitted by a firm, it must be signed separately either by one or all the partners or person duly authorized by the partners, it must be signed on behalf of the firm by a person holding the requisite authorizations, such authorizations to be produced with the tender, and it must disclose that the firm is duly registered under the Indian Partnership Act, 1952.

3. Receipts for payment on account of work done, when executed by a firm, must also be signed by one or all the partners or a duly authorized signatory of the firm.

Applicable for Item Rate Tender only (PWD- 3)

4. Any person who submits a tender shall fill up the usual printed form, stating at what rate he is willing to undertake each item of the work. Tenders, which propose any alteration in the work specified in the said form of invitation to tender, or in the time allowed for carrying out the work, or which contain any other conditions of any sort, will be liable to rejection. No single tender shall include more than one work, but contractors who wish to tender two or more works shall submit separate tenders for each; with the nature and number of works to which they refer on the envelope.

The rate(s) must be quoted in decimal coinage. Amounts must be quoted in full rupees by ignoring fifty paisa and less and considering more than fifty paisa as rupee one.

Applicable for Percentage Rate Tender only (PWD - 2)

4A. In case of Percentage Rate Tenders, tenderer shall fill up the usual printed form, stating at what percentage below / above (in figures as well as in words) the total estimated cost given in Schedule of Quantities at Schedule- A, he will be willing to execute the work Tenders, which propose any alteration in the work specified in the said form of invitation tender, or in the time allowed for carrying out the work, or which contain any other conditions of any sort, will be liable to rejection. No single tender shall include more than one work but contractors who wish to tender for two or more works shall submit separate tender for each. Tender shall have the name and number of the works to which they refer, written on the envelope.

If for any special reasons, the contract provides for the payments for work done to be made at a specified percentage below or above the rates entered in the sanctioned estimate of the work (or the Scheduled of Rates), it should be stated in clear terms in the contract that the deductions or additions, as the case may be of the percentage, will be calculated on the gross, and not the net amounts of thebills for work done and in fixing the percentage it should be borne in mind that the calculations will be made.

5. The officer inviting tender or his duly authorized assistant will open tenders in the presence of any intending contractors who may be present at the time and will enter the amount of the several tenders in a comparative statement in a suitable form. In the event of a tender being accepted, a receipt for the earnest money forwarded therewith shall thereupon be given to the contractor who shall thereupon for the purpose of identification sign copies of the specifications and other documents mentioned in Rule-I. In the event of a tender being rejected, the earnest money forwarded with such unaccepted tender shall thereupon be returned to the contractor remitting the same, without any interest.

6. The officer inviting tenders shall have the right of rejecting all or any of the tenders and will not be bound to accept the lowest or any other tender.

7. The receipt of an accountant or clerk for any money paid by the contractor will not be considered as an acknowledgment or payment to the officer inviting tender and the contractors shall be responsible for seeing that he procures a receipt signed by the office inviting tender or a duly authorized person.

8. The memorandum of work tendered for and the schedule of materials to be supplied by the department and their issue-rates, shall be filled and completed in the office of the officer inviting tender before the tender form is issued. If a form is issued to an intending tenderer without having been so filled in and incomplete, he shall request the officer to have this done before he completes and delivers his tender.

9. For works of sensitive nature the tenderers shall sign a declaration under the Official Secrets Act 1923, for maintaining secrecy of the tender documents drawing or other records connected with the work given to them. The unsuccessful tenderers shall return all the drawing given to them.

10. In the case of Item Rate Tenders, only rates quoted shall be considered. Any tender containing percentage below/above the rates quoted is liable to be rejected. Rates quoted by the contractor in item rate tender in figures and words shall be accurately filled in so that there is no discrepancy if any discrepancy found or the rates which correspond with the amount worked out of an item is not worked out by the contractor or it does not correspond with the rates written either in figures or in words then the rates quoted by the contractor in words shall be taken as correct. Where the rates quoted by the contractor in figures and in words tally but the amount is not worked out correctly, the rates quoted by the contractor will unless otherwise proved be taken as correct and not the amount.

Applicable for Item Rate Tender only (PWD - 3)

10A. In case of Percentage Rate Tenders only percentage quoted shall be considered. Any tender containing item rates is liable to be rejected. Percentage quoted by the contractor in percentage rate tender shall be accurately filled in figures and words, so that there is no discrepancy. However if the contractor has worked out the amount of the tender and if any discrepancy is found in the percentage quoted in words and figures, the percentage which corresponds with the amount worked out by the contractor shall, unless otherwise proved, be take as correct. If the amount of the tender is not worked out by the contractor or it does not correspond with the percentage written either in figures or in words then the percentage quoted by the contractor in words shall be taken as correct. Where the percentage quoted by the contractor in figures and in words tally but the amount is not worked out correctly, the percentage quoted by the contractor will, unless otherwise proved, be taken as correct and not the amount.

Applicable for Percentage Rate Tender only (PWD - 2)

11. In the case of any tender where unit rates of any item/items appear unrealistic, such tender will be considered as unbalanced and in case the tenderer is unable to provide satisfactory explanation such a tender is liable to be disqualified and rejected.

12. All rates shall be quoted on the tender form. The amount for each item should be worked out and requisite totals given. Special care should be taken to write the rates in figures as well as in words and the amount in figures only, in such a way that interpolation is not possible. The total amount should be written both in figures and in words. In case of figures, the word 'Rs' should be written before the figure of rupees and word 'P' after the decimal figures, e.g. 'Rs 2.15 P' and in case of words, the word, 'Rupees' should precede and the word 'Paise' should be written in the end. Unless the rate is in whole rupee and followed by the word

Applicable for Item Rate Tender only

'only' it should invariably be up to two decimal places. While quoting the rate in schedule of quantities, the word 'only' should be written closely following the amount and it should not be written in the next line.

12A. In Percentage Rate Tender, the tenderer shall quote percentage below/above (in figures as well as in words) at which he will be willing to execute the work. He shall also work out the total amount of his offer and the same should be written in figures as well as in words in such a way that no interpolation is possible. In case of figures, the word 'Rs' should be written before the figure of rupees and word P after the decimal figures, e.g. 'Rs 2.15 P and in case of words, the word 'Rupees' should precede and the word 'paisa' should be written at the end.

Applicable for Percentage Rate Tender only (PWD- 2)

The Quoted rate less than x % below the BOQ cost will be unworkable and bid will be rejected where x = 10 %; if materials will not be issued by BUIDCo. And if materials will be issued by BUIDCo then

$$X = (A - B) / A \times 10\ \%$$

Where A = BOQ Cost

B = Cost of materials stipulated to be issued by BUIDCo.

Where the value of X will not be less than 10% in other words it will be within 10%.

13. (i) The contractor whose tender is accepted, will be required to furnish performance guarantee of 2 (two percent) including earnest money of the tendered amount within specified period. This guarantee shall be in the form of Govt. Securities or fixed deposit receipt of any scheduled bank, guarantee bonds of any scheduled bank or State Bank of India or Bank guarantee from any schedule bank in the State for works of more than one crore.

(ii) The contractor whose tender is accepted will also be required to furnish by way of Security Deposit for the fulfillment of his contract, an amount equal to 8 % of the tendered value of the work. The security deposit will be collected by deductions from the running bills of the contractor at the rates mentioned above

14. On acceptance of the tender, the name of the accredited representative(s) of the contractor who would be responsible for taking instructions from the Engineer-in-Charge shall be communicated in writing to the Engineer-in-Charge.

15. Sales-tax, purchase tax, turnover tax, service tax, entry tax royalty or any other tax on material in respect of this contract shall be payable by the Contractor and Government will not entertain any claim whatsoever in respect of the same.

16. The contractor shall give a list of both gazetted and non-gazetted P.W.D. employees related to him posted in the division, if any.

17. The tender for the work shall not be witnessed by a contractor or contractors who himself / themselves has / have tendered or who may and has / have tendered for the same work. Failure to observe this condition would render, tenders of the contractors tendering, as well as witnessing the tender, liable to summary rejection.

18. The tender for composite work includes in addition to building work all other works such as sanitary and water supply installations drainage installation, electrical work, horticulture work, roads and paths etc. The tenderer apart from being a registered contractor (B&R) of appropriate class, must associate himself with agencies of appropriate class which are eligible to tender for sanitary and water supply drainage, electrical and horticulture works in the composite tender.

19. The contractor shall submit list of works which are in hand (progress) in the following form:-

Name of Work	Name of Particular of Div. where work is	Value of Work	Position of work in Progress	Remarks
1	2	3	4	5

20. The contractor shall comply with the provisions of the Apprentices Act 1961, and the rules and orders issued thereunder from time to time. If he fails to do so, his failure will be a breach of the contract and the General Manager (Works) / Project Director may in his discretion without prejudice to any other right or remedy available in law cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.

CONDITIONS OF CONTRACT

Definitions:

1. The contract means the document forming the tender and acceptances thereof and the formal agreement executed between the competent authority on behalf of the Governor of Bihar and the Contractor, together with the documents referred to therein including these conditions, the specifications, designs, drawings and instructions issued from time to time form one contract and shall be complementary to one another.

2. In the contract, the following expressions shall, unless the context otherwise requires have the meanings, hereby respectively assigned to them :-

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

   ii) The site shall mean the land/or other places on. into or through which work is to be executed under the contract or any adjacent land, path or street through which work is to be executed under the contract or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the contract.

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

   iv) The Engineer-in-Charge means the Engineer officer who shall supervise and be in-charge of the work and who shall sign the contract on behalf of the Governor of Bihar as mentioned in Schedule 'F' hereunder.

   v) Government or Government of Bihar shall mean the Governor of Bihar.

   vi) Excepted Risk are risks due to riots (other than those on account of contractor employees), war (whether declared or not) invasion, act of foreign enemies, hostilities, civil war, rebellion revolution, insurrection, any act of Government, damages from aircraft, acts of God, such as earthquake, lightening and unprecedented floods, and other causes over which the contractor has no control and accepted as such by the Accepting Authority Provided that the contractor is also to show that he has taken all due precautions to avoid / un minimise any adverse after / damage from the above or causes solely due to use or occupation by Government of the part of the works in respect of which a certificate of completion has been issued or a caused solely due to Government's faulty design of works.

   vii) Bill of quantity means the price and completed Bill of Quantities forming part of the Bid.

   viii) The Defect liability certificate is the certificate issued by Engineer-in-Charge after defect liability period has ended and upon correction of defects by the contractor.

   ix) The defect liability period will be decided by BUIDCO for different nature of works from date of completion of the work and must be mentioned in the agreement.

   It will be decided by the department for different nature of work from time to time as mentioned in contract Data.

   x) The intended completion date is the time intended to complete the work by the contractor.

   xi) 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 date.

   xii) A sub contractor is a person or corporate body who has a contract with the contractor to carry out a part of the construction work in the contract, which includes work on the site.

xiii) Temporary works are works designed, constructed, installed and removed by the contractor that are needed for construction or installation of the works.

xiv) Market Rate shall be the rate as decided by the competent authority on the basis of the cost of materials and labour at the site where the work is to be executed plus the percentage mentioned in Schedule 'F' to cover, all overheads and profits.

xv) Schedule(s) referred to in these conditions shall mean the relevant schedule(s) annexed to the tender papers or the standard Schedule of Government mentioned in Schedule 'F' hereunder, with the amendments thereto issued up to date of receipt of the tender.

xvi) Department means any department of Government of Bihar, which invite tenders on behalf of Governor of Bihar as specified in schedule 'F'.

xvii) Specifications means the specifications followed by relevant department of the Government of India / State Government.

xviii) Tender value means the value of the entire work as stipulated in the letter award.

Scope and Performance

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

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

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

Works to be carried out:

6. The work to be carried out under the Contract shall, except as otherwise provided these conditions, include all labour, materials, tools, plants, equipment and transport which may be required in preparation of and for and in the full and entire execution and completion of the works. The descriptions given in the Schedule of Quantities (Schedule - A) shall unless otherwise stated, be held to include wastage on materials, carriage and cartage, carrying and return of empties, hoisting, setting, fitting and fixing in position and all other labours necessary in and for the full and entire execution and completion of the work as aforesaid in accordance with good practice and recognized principles.

Sufficiency of Tender

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

Discrepancies and Adjustment of Errors

8. The several documents forming the contract are to be taken as mutually explanatory of one another, detailed drawings being followed in preference to small scale drawing and figured dimensions in preference to scale and special conditions in preference to General Conditions.

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

i) Description of Schedule of Quantities.

ii) Particular Specification and Special Condition, if any

iii) Drawings.

iv) MORT & H specification.

v) Indian Standard Specifications of B.I.S.

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

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

Signing of Contract

9. The successful tenderer / contractor, after submitting the performance guarantee i.e. within 15 days of receipt of letter of acceptance shall attend the office of the Engineer-in-Charge for authentication signing and completion of the contractor document and execute the agreement consisting of:

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

ii) Standard P.W.D. Form as mentioned in Schedule 'F' consisting of :

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

iii) Drawing.

CLAUSE OF CONTRACT

CLAUSE 1

Performance Guarantee

(i) The contractor shall submit an irrevocable PERFORMANCE GUARANTEE of 2% (Two percent) of the tendered amount including earnest money in the shape as mentioned in the Bihar Financial Rules or Bank Guarantee (for work costing more than one crore) or any other deposits mentioned for his proper performance of the contract agreement, (not withstanding and/or without prejudice to any other provisions in the contract) within period specified in scheduled 'F' from the date of issue of letter of acceptance. This period can be further extended by the Engineer-in-Charge up to a maximum period as specified in schedule 'F' on written request of the contractor stating the reason for delays in procuring the Bank Guarantee, to the satisfaction of the Engineer-in-Charge. This guarantee shall be in the form of N.S.C. of Post Office/ Pledged in favour of department; D.D. of any Scheduled Bank or State Bank of India or Bank Guarantee (for work costing more than Rupees one Crore.

(ii) The performance Guarantee shall be initially valid up to 28 days beyond the defect liability.

(iii) The Engineer-in-Charge shall not make a claim under the Performance guarantee except for amounts to which the Governor of Bihar is entitled under the contract (notwithstanding and/or without prejudice to any other provisions in the contract agreement) in the event of:

(a) Failure by the contractor to extend the validity of the Performance Guarantee as described herein above, in which event the Engineer-in-Charge may claim the full amount of the Performance guarantee.

(b) Failure by the contractor to pay Governor of Bihar any amount due, either as agreed by the contractor or determined under any of the Clauses/Conditions of the agreement, within 30 days of the service of notice to this effect by Engineer-in-Charge.

(c) Failure by the contractor to rectify any defects as defined in the defect liability clause in the schedule – F of contract data to the satisfaction of the Engineer in charge.

(iv) In the event of the contract being determined or rescinded under provisions of any of the clause/condition of the agreement, the performance guarantee shall stand forfeited in full and shall be absolutely at the disposal of the Governor of Bihar.

CLAUSE 1 A

Recovery of Security Deposit

The person/persons whose tender(s) may be accepted (hereinafter called the contractor) shall permit BUIDCo at the time of making any payment to him for work done under the contract to deduct a sum at 8 % (eight percent) from the gross amount of each running bill till full amount of security deposit 10% (ten percent) of agreement value or value of work (whichever is higher) is reached. If value of work exceeds the agreement value, security deposit (10%) will be recovered for the exceeded work.

All compensations or the other sums of money payable by the contractor under the terms of this contract may be deducted from, or paid by the sale of a sufficient part of his security deposit or from the interest arising there from, or from any sums which may be due to or may become due to the contractor by Government on any account whatsoever and in the event of his Security Deposit being reduced by reason of any such deductions or sale as aforesaid, the contractor shall within 10 days make good in cash or fixed deposit receipt tendered by the State Bank of India or by Scheduled Banks or Government Securities (if deposited for more than 12 months) endorsed in favour of the Engineer-in-Charge, any sum or sums which may have been deducted from, or raised by sale of his security deposit or any part thereof. The security deposit shall be collected from the running bills of the contractor at the rates

mentioned above and the earnest money at the time of tenders will be treated a part of the Security Deposit.

CLAUSE 2

Compensation for Delay (Liquidated Damage

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

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

i) *Compensation for delay of work -@ 2 % per month of delay to be computed on per Day basis*

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

The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this or any other contract with the BUIDCo. In case, the contractor dies not achieve a particular milestone mentioned in schedule- F, or the rescheduled milestone(s) in terms of Clause 5.4, the amount shown against that milestone shall be withheld, to be adjusted against the compensation levied at the final grant of extension of time. Withholding of this amount on failure to achieve a milestone, shall be automatic without any notice to the contractor. However, if the contractor catches up with the progress of work on the subsequent milestone(s), the withheld amount shall be released. In case the contractor fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be withheld. However, no interest, whatsoever, shall be payable on such withheld amount.

CLAUSE 2A

Incentive for early completion

In case, the contractor completes the work ahead of scheduled completion time, a bonus @ 1% (one percent) of the tendered value per month computed on per day basis, shall be payable the contractor, subject to a maximum limit of 5% (five percent) of the tendered value. The amount of bonus, if payable, shall be paid along with final bill after completion of work. Provided always that provision of the Clause 2A shall be applicable only when so provided in 'Schedule F'.

CLAUSE 3

When Contract can be Determined / Resigned

Subject to the other provisions contained in this clause the Engineer-In-Charge may, without prejudice to his any other rights or remedy against the contractor in respect of any delay inferior workmanship, any claims for damages and/or any other provisions of this contract or otherwise, and whether the date of completion has or has not elapsed, by notice in writing absolutely determine the contract in any of the following cases:

i) It the contractor having been given by the Engineer-in-Charge a notice in writing to rectify, reconstruct or replace any defective work or that the work is being performed in an inefficient or otherwise improper or unworkman like manner shall omit to comply with the requirement of such notice for a period of seven days thereafter.

ii) If the contractor being a company shall pass a resolution or the court shall make an order that the company shall be wind up or if a receiver or a manager on behalf of a creditor shall be appointed or if circumstances shall arise which entitle the court or the

creditor to appoint a receiver or a manager or which entitle the court to make a winding up order.

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

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

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

vi) If the contractor commits any acts mentioned in Clause 21 hereof:

vii) If the work is not started by the contractor within 1/8th of the stipulated time subject to the maximum of 45 days.

When the contractor has made himself liable for action under any of the cases aforesaid, the Engineer-in-Charge on behalf of the Governor of Bihar shall have powers:

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

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

In the event of above course(s) being adopted by the Engineer-in-Charge, the contractor shall have no claim to compensation for any loss sustained by him by reasons of his having purchased or procured any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of the contract. And in case action is taken under any of the provision aforesaid the contractor shall not be entitled to recover or be paid any sum for any work thereof or actually performed under this contract unless and until the Engineer-in-Charge has certified in writing the performance of such work and the value payable in respect thereof and he shall only be entitled to be paid the value so certified.

CLAUSE 3A

In case, the work cannot be started due to reasons not within the control of the contractor as decided by Chief Engineer within ¼th of the stipulated time for completion of work, either party may close the contract. In such eventuality, the Earnest Money deposit and the Performance Guarantee of the contractor shall be refunded, but no payment on account of interest, loss of profit or damages etc. shall be payable at all. the reasons shall be examined by the Superintending Engineer and his decision shall be final and binding.

CLAUSE 4

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

In any case in which any of the powers conferred upon the Engineer-in-Charge by Clause- 3 thereof, shall have become exercisable and the same are not exercised the non-exercise thereof shall not constitute a waiver of any of the conditions hereof and such powers shall notwithstanding be exercisable in the event of any future case of default by the contractor and

the liability of the contractor for compensation shall remain unaffected. In the event of the Engineer-in-Charge putting in force all or any of the powers vested in him under the preceding clause he may, if he so desires after giving a notice in writing to the contractor, take possession of (or at the sole discretion of the Engineer-in-Charge which shall be final and binding on the contractor) use as on hire (the amount of the hire money being also in the final determination of the Engineer-in-Charge) all or any tools, plant, materials and stores, in or upon the works, or the site thereof belonging to the contractor, or procured by the contractor and intended to be used for the execution of the work. or any part thereof, paying or allowing for the same in account at the contract rates or, in the case of these not being applicable, at current market rates to be certified by the Engineer-in-Charge, whose certificate thereof shall be final, and binding on the contractor, clerk of the works, foreman or other authorized agent to remove such tools, plant, materials, or stores from the premises (within a time to be specified in such notice) in the event of the contractor failing to comply with any such requisition, the Engineer-in-Charge may remove them at the contractor's expense or sell them by auction or private sale on account of the contractor and his risk in all respects and the certificate of the Engineer-in-Charge as to the expenses of any such removal and the amount of the proceeds and expenses of any such sale shall be final and conclusive against the contractor.

CLAUSE 5

Time and Extension for Delay

The time allowed for execution of the Works as specified in the Schedule 'F' or the extended time in accordance with these conditions shall be the essence of the Contract. The execution of the works shall commence from such time period as mentioned in letter of acceptance or from the date of handing over of the site whichever is later. If the Contractor commits default in commencing the execution of the work as aforesaid, Government shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the security deposit absolutely.

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

5.2 If the work(s) be delayed by.

i) force majeure, or

ii) Serious loss or damage by fire, or

iii) Civil commotion, local.

iv) delay on the part of other contractors or tradesmen engaged by Engineer-in-Charge in executing work not forming part of the Contract, or

v) Non-availability of stores, which are the responsibility of Government to supply or

vii) Non-availability or break down of tools and Plant to be supplied or supplied by Government or

vii) any other cause which, in the absolute discretion of the authority mentioned in Schedule 'F' is beyond the Contractor's control.

then upon the happening of any such event causing delay, the Contractor shall immediately give notice thereof in writing to the Engineer-in-Charge but shall nevertheless use constantly his best endeavors to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-in-Charge to proceed with the works.

5.3 Request for the rescheduling of Milestones and extension of time, to be eligible for consideration, shall be made by the contractor in writing within fourteen days of the happening of the hindering event causing delay on the prescribed form. The Contractor may also, if practicable, indicate in such a request the period for which extension is desired.

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

5.5 The basic centerlines, reference points and benchmarks will be fixed by the department. The contractor shall established at his own cost at suitable points, additional reference lines and bench marks as may be necessary and instructed by the engineer-in-charge. The contractor shall remain responsible for the sufficiency and accuracy of all the bench marks and reference lines.

CLAUSE 5A

The Engineer may require the contractor to attend a progress review meeting during execution of work.

The Engineer shall record the minutes of the meeting and provide a copy to the Contractor for compliance. These minutes will be a part of evidence in case of any request for extension of time action against the contractor.

CLAUSE 6

Measurement of Work Done

Engineer-in-Charge shall, except as otherwise provided, ascertain and determine measurement and the value in accordance with the contract of work done.

All measurement of all items having financial value shall be entered in Measurement Book and/or level field book so that a complete record is obtained of all works perform under the contract.

All measurements and levels shall be taken jointly by the Engineer-in-Charge or his authorized representative and by the contractor or his authorized representative at bast once in a month during the progress of the work and such measurements shall be signed and dated by the Engineer-in-Charge and the contractor or their representatives in token their acceptance. If the contractor objects to any of the measurements recorded, a note shall be made to that effect with reason and signed by both the parties.

If for any reason the contractor or his authorized representative is not available and the work of recording measurements is suspended by the Engineer-in-Charge or his representative, the Engineer-in-Charge and the Department shall not entertain any claim from contractor for any loss or damages on this account. If the contractor or his authorized representative does not remain present at the time of such measurements after the contractor or his authorized representative has been given a notice in writing three (3) days in advance or fails to countersign or to record objection within a week from the date of the measurement, then such measurements recorded in his absence by the Engineer-in-Charge or his representative shall be deemed to be accepted by the Contractor.

The contractor shall, without extra charge, provide all assistance with every appliance labour and other things necessary for measurements and recording levels.

Except where any general or detailed description of the work expressly shows to the contrary, measurements shall be taken in accordance with the procedure set forth in the specifications notwithstanding any provision in the relevant Standard Method of measurement or any general or local custom. In the case of items which are not covered by specifications, measurements shall be taken in accordance with the relevant standard method of measurement issued by the Bureau of India Standards and if for any item no such standard is available then a mutually agreed method as approved by the department shall be followed.

The contractor shall give not less than seven day notice to the Engineer-in-Charge or his authorized representative in charge of the work before covering up or otherwise placing beyond the reach of measurement any work in order that the same may be measured and correct dimension thereof be taken before the same is covered up or placed beyond the reach of measurement and shall not cover up and place beyond reach of measurement any work without consent in writing of the Engineer-n-Charge or his authorized representative in charge of the work who shall within the aforesaid period of seven days inspect the work, and if any work shall be covered up or placed beyond the reach of measurements without such notice having been given or the Engineer-in-Charge's consent being obtained in writing the same shall be uncovered at the contractor's expense, or in default thereof no payment or allowance shall be made for such work or the materials with which the same was executed.

Engineer-in-Charge or his authorized representative may cause either themselves or through another officer of the department to check the measurements recorded jointly or otherwise as aforesaid and all provisions stipulated herein above shall be applicable to such checking of measurements or levels.

It is also a term of this contract that recording of measurements of any item of work in the measurement book and/or its payment in the interim, on account or final bill shall not be considered as conclusive evidence as to the sufficiency of any work or material to which it relates nor shall it relieve the contractor from liabilities from any over measurement defects noticed till completion of the defects liability period.

CLAUSE 7

Payment on Intermediate Certificate to be Regarded as Advances

No payment shall be made for work for less than the estimated work of Rs. 2.5 Lacs till the whole of the work shall have been completed and certificate of completion given. For works estimated to cost over Rs. 2.5 Lacs the interim or running account bill shall be submitted by the contractor for the work executed on the basis of such recorded measurements on the format of the Department in triplicate on or before the date of every month fixed for the same by the Engineer-in-Charge. The contractor shall not be entitled to be paid any such interim payment if the gross work done together with net payment/ adjustment of advances for material collected, if any, since the last such payment is less than the amount specified in Schedule ‘F’ , in which case the interim bill shall be prepared on the appointed date of the month after the requisite progress is achieved. The Engineer-in-Charge shall arrange to have the bill verified by taking or causing to be taken, where necessary, the requisite measurements of the work. In the event of the failure of the contractor to submit the bills, Engineer-in-Charge shall prepare or cause to be prepared such bills in which event no claims whatsoever due to delays on payment including that of interest shall be payable to the contractor. Payment on account of amount admissible shall be made by the Engineer-in-Charge certifying the sum to which the contractor is considered entitled by way of interim payment at such rates as decided by the Engineer-in-Charge. The amount admissible shall be paid by 10th working day after the day of presentation of the bill by the Contractor to the Engineer-in-Charge or his Dy. Project Director together with the account of the material issued by the department, or dismantled materials, if any. In the case of works outside the headquarters of the Engineer-in-Charge the period of ten working days will be extended to fifteen working days.

All such interim payments shall be regarded as payment by way of advances against final payment only and shall not preclude the requiring of bad, unsound and imperfect or unskilled work to be rejected, removed, taken away and reconstructed or re-erected. Any certificate given by the Engineer-in-Charge relating to the work done or materials delivered forming part of such payment may be modified or corrected by any subsequent such certificate(s) or by the final certificate and shall not by itself be conclusive evidence that any work or materials to which it relates is/are in accordance with the contract and specifications. Any such interim payment, or any part thereof shall not in any respect conclude, determine or affect in any way powers of the Engineer-in-Charge under the contract or any of such payments be treated as final settlement and adjustment of accounts or in any way vary or affect the contract.

Pending consideration of extension of date of completion interim payments shall continue to be made as herein provided as per clause - 2, without prejudice to the right of the department

to take action under the terms of this contract for delay in the completion of work, if the extension of date of completion is not granted by the competent authority.

CLAUSE 8

Completion Certificate and Completion Plans

Within ten days of the completion of the work, the contractor shall give notice of such completion to the Engineer-in-Charge and within fifteen days of the receipt of such notice the Engineer-in-Charge shall inspect the work and if there is no defect in the work shall furnish the contractor with a final certificate of completion, otherwise a provisional certificate of physical completion indicating defects (a) to be rectified by the contractor and/or (b) for which payment will be made at reduced rates, shall be issued. But no final certificate of completion shall be issued, nor shall the work be considered to be complete until the contractor shall have removed from the premises on which the work shall be executed all scaffolding, surplus materials, rubbish and all huts and sanitary arrangements required for his/their work people on the site in connection with the execution of the works as shall have been erected or constructed by the contractor(s) and cleaned off the dirt from all wood work, doors, windows, walls, floor or other parts of the building, in, upon, or about which the work is to be executed or of which he may have had possession for the purpose of execution thereof, and not until the work shall have been measured by the Engineer-in-Charge. If the contractor shall fail to comply with the requirements of this clause as to removal of scaffolding, surplus materials and rubbish and all huts and sanitary arrangements as aforesaid and cleaning off dirt on or before the date fixed for the completion of work, the Engineer-in-Charge may at the expense of the contractor remove such scaffolding surplus materials and rubbish etc. and dispose of the same as he thinks fit and clean off such dirt as aforesaid, and the contractor shall have no claim in respect of scaffolding or surplus materials as aforesaid except for any sum actually realised by the sale thereof.

CLAUSE 8A

Contractor to Keep Site Clean

When the annual repairs and maintenance of works are carried out, the splashes and droppings from white washing, color washing, painting etc. on walls, floor, windows etc. shall be removed and the surface cleaned simultaneously with the completion of these items of work in the individual rooms, quarters or premises etc. where the work is done without waiting for the actual completion of all the other items of work in the contract. In case the contractor fails to comply with the requirements of this clause, the Engineer-in-Charge shall have the right to get this work done at the cost of the contractor either departmentally or through any other agency. Before taking such action, the Engineer-in-Charge shall give ten days notice in writing to the contractor.

CLAUSE 8 B

Completion Plans to be Submitted by the Contractor

The contractor shall submit completion plan as required vide General Specifications for Electrical works (Part-I internal) 1972 and (Part-II External) 1974 as applicable within thirty days of the completion of the work.

In case, the contractor fails to submit the completion plan as aforesaid, he shall be liable to pay a sum equivalent to 2.5% of the value of the work subject to a ceiling of Rs. 15,000 (Rs. Fifteen thousand only) as may be fixed by the General Manager (Works) concerned and in this respect the decision of the General Manager(Works) shall be final and binding on the contractor.

CLAUSE 9

Payment of Final Bill

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

Charge or his authorized Dy. Project Director, complete with account of materials issued by the Department and dismantled materials.

i) If the Tendered value of work is up to Rs. 1 crores: 2 months

ii) If the Tendered value of work exceeds Rs. 1 crores: 4 month

CLAUSE 9 A

Payment of Contractor's Bills to Banks

Payments due to the contractor may, if so desired by him, be made to his bank instead of direct to him provided that the contractor furnishes to the Engineer-in-Charge (1) an authorisation in the form of a legally valid document such as a power of attorney conferring authority on the bank to receive payments and (2) his own acceptance of the correctness of the amount made out as being due to him by BUIDCo or his signature on the bill or other claim preferred against BUIDCo before settlement by the Engineer-in-Charge of the account or claim by payment to the bank. While the receipt given by such banks shall constitute a full and sufficient discharge for the payment, the contractor shall wherever possible present his bills duly receipted and discharges through his bankers.

Nothing herein contained shall operate to create in favour of the bank any rights or equities vis-a-vis the Governor of Bihar.

CLAUSE 10

Materials supplied by BUIDCo

Materials which BUIDCo will supply in rare case are shown in schedule 'B' which also stipulates quantum, place of issue and rate(s) to be charged in respect thereof. The contractor shall be bound to procure them from the Engineer-in-Charge.

As soon as the work is awarded, the contractor shall finalise the programme for the completion of work as per clause 5 of this contract and shall give his estimates of materials required on the basis of drawings/or schedule of quantities of the work. The Contractor shall give in writing his requirement to the Engineer-in-Charge which shall be issued to him keeping in view the progress of work as assessed by the Engineer-in-Charge, in accordance with the agreed phased programme of work indicating monthly requirements of various materials. The contractor shall place his indent in writing for issue of such materials at least 7 days in advance of his requirement.

Such materials shall be supplied for the purpose of the contract only and the value of the materials so supplied at the rates specified in the aforesaid schedule shall be set off or deducted, as and when materials are consumed in items of work (including normal wastage) for which payment is being made to the contractor, from any sum then due or which may therefore become due to the contractor under the contract or otherwise or from the security deposit. At the time of submission of bills the contractor shall certify that balance of materials supplied is available at site in original good condition.

The contractor shall submit along with every running bill (on account or interim bill) material wise reconciliation statements supported by complete calculations reconciling total issue, total consumption and certified balance (diameter/section-wise in the case of steel) and resulting variations and reasons therefore. Engineer-in-Charge shall (whose decision shall be final and binding on the contractor) be within his rights to follow the procedure of recovery in clause 42 at any stage of the work if reconciliation is not found to be satisfactory.

The contractor shall bear the cost of getting the material issued, loading, transporting to site, unloading, storing under cover as required, cutting assembling and joining the several parts together as directed by the engineer-in-charge. Notwithstanding anything to the contrary contained in any other clause of the contract and (or the PWD Code) all stores/materials so supplied to the contractor or procured with the assistance of the BUIDCo shall remain the absolute property of BUIDCo and the contractor shall be the trustee of the stores/materials, and the said stores/materials shall not be removed/disposed off from the site of the work on any account and shall be at all times open to inspection by the Engineer-in-Charge or his authorized agent. Any such stores/materials remaining unused shall be returned to the Engineer-in-Charge in as good a condition in which they were originally supplied at a require,

but in case it is decided not to take back the stores/materials the contractor shall have no claim for compensation on any account of such stores/materials so supplied to him as aforesaid and not used by him or for any wastage in or damage to in such stores/materials.

On being required to return the stores/materials, the contractor shall hand over the stores/materials on being paid or credited such price as the Engineer-in-Charge shall determine, having due regard to the condition of the stores/materials. The price allowed for credit to the contractor, however, shall be at the prevailing market rate not exceeding the amount charged to him, excluding the storage charge, if any. The decision of the Engineer-in-Charge shall be final and conclusive. In the event of breach of the aforesaid condition, the contractor shall in addition to the throwing himself open to account for contravention of the terms of the licenses or permit and/or for criminal breach of trust, be liable to Government for all advantages or profits resulting or which in the usual course would have resulted to him by reason or such breach. Provided that the contractor shall in no case be entitled to any compensation or damages on account of any delay in supply or non-supply thereof all or any such materials and stores provided further that the contractor shall be bound to execute the entire work if the materials are supplied by the Government within the original scheduled time for completion of the work plus 50% thereof or schedule time plus 6 months whichever is more if the time of completion of work exceeds 12 months but if a part of the materials only has been supplied within the aforesaid period then the contractor shall be bound to do so much of the work as may be possible with the materials and stores supplied in the aforesaid period. For the completion of the rest of the work, the contractor shall be entitled to such extension of time as may be determined by the Engineer-in-Charge whose decision in this regard shall be final and binding on the contractor.

The contractor shall see that only the required quantities of materials are got issued. Any such material remaining unused and in perfectly good/original condition at the time of completion or determination of the contract shall be returned to the Engineer-in-Charge at the stores from which it was issued or at a place directed by him by a notice in writing. The contractor shall not be entitled for loading, transporting, unloading and stacking of such unused material except for the extra lead, if any involved, beyond the original place of issue. Quantities issued in excess of requirement with respect to work done and not returned back to the department, recovery will be made of double of issue rate.

CLAUSE 10 A

Materials to be provided by the Contractor

The contractor shall, at his own expense, provide all materials, required for the works other than those, which are stipulated, to be supplied by the BUIDCo.

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

The Contractor shall at his risk and cost submit the samples of materials to be tested or analysed and shall not make use of or incorporate in the work any materials represented by the samples until the required tests or analysis have been made and materials finally accepted by the Engineer-in-Charge. The Contractor shall not be eligible for any claim or compensation either arising out of any delay in the work or due to any corrective measures required to be taken on account of and as a result of testing of materials.

The contractor shall, at his risk and cost, make all arrangements and shall provide all facilities as the Engineer-in-Charge may require for collecting, and preparing the required number of

samples for such tests at such time and to such place or places as may be directed by the Engineer-in-Charge and bear all charges and cost of testing unless specifically provided for otherwise elsewhere in the contract or specifications. The Engineer-in-Charge or his authorized representative shall at all time have access to the works and to all workshops and places where work is being prepared or from where materials, manufactured articles or machinery are being obtained for the works and the contractor shall afford every facility and every assistance in obtaining the right to such access.

The Engineer-in-Charge shall have full powers to require the removal from the premises of all materials which in his opinion are not in accordance with the specifications and in case of default the Engineer-in-Charge shall be at liberty to employ at the expense of the contractor, other persons to remove the same without being answerable or accountable for any loss for damage that may happen or arise to such materials. The Engineer-in-Charge shall also have full powers to require other proper materials to be substituted thereof and in case of default the Engineer-in-Charge may cause the same to be supplied and all costs which may attend such removal and substitution shall borne by the Contractor.

CLAUSE 10 B

Secured Advance on Non-perishable Materials

i) The contractor, on signing an indenture in the form to be specified by the Engineer-in-Charge, shall be entitled to be paid during the progress of the execution of the work up to 75% of the assessed value of any materials which are in the opinion of the General Manager (Works) nonperishable, non-fragile and noncombustible and are in accordance with the contract and on the site in connection therewith and are adequately stored and/or protected against damage by weather or other causes but which have not at the time of advance been incorporated in the works. When materials on account of which advance has been made under this sub-clause are incorporated in the work the amount of such advance shall be recovered/deducted from the next payment made under any or the clause or clauses of this contract.

ii) Mobilization advance not exceeding 10% of the tendered value may be given, if requested by the contractor in writing within one month of the order to commence the work. In such a case the contractor shall execute a Bank Guarantee/ Bond from a Scheduled Nationalised Bank as specified by the Engineer-in-Charge for the full amount of such advance before it is released. Such advance shall be in two or more installments to be determined by the Engineer-In-charge at his absolute discretion. The first installment of such advance before shall be released by the Engineer-in-Charge to the contractor on a request made by the contractor to the Engineer-in-Charge in this behalf. The second and subsequent installment shall be released by the Engineer-in-Charge only after the contractor furnishes a proof of the satisfactory utilisation of the earlier installment to the entire satisfaction of the Engineer-In-Charge.

Plant & Machinery & Shuttering Material Advance

iii) An advance for plant machinery required for the work and brought to site by the Contractor may be given if requested by the contractor in writing within one month of bringing such plant and machinery to site. Such advance shall be given on such plant and machinery which in the opinion of the Engineer-in-Charge will add to the expeditious execution of work and improve the quality of work. The amount of advance shall be restricted to 5% of the tender value. In the case of new plant and equipment to be purchased for the work the advance shall be restricted to 85% of the price of such new plant and equipment paid by the contractor for which the contractor shall produce evidence satisfactory to the Engineer-in-Charge and approval from Engineer-in-Charge. In the case of second hand and used plants and equipment, the amount of such advance shall be limited to 50% of the depreciated value of plant and equipment as may be decided by the Engineer-in-Charge. The contractor shall, if so required by the Engineer-in-Charge, submit the statement value of such old plant and equipment duly approved by a Registered Value recognized by the Central Board of Direct Taxes under the Income-Tax Act, 1961. No such advance shall be paid on any plant and equipment of perishable nature and on the plant and equipment of a value less than Rs. 50,000/-. Seventy five percent of such amount of advance shall be paid after the plant & equipment is brought to site and balance twenty five percent on successfully commissioning the same only after approval from Engineer-in-Charge.

Leasing of equipment shall be considered at par with purchase of equipment and shall be covered by tripartite agreement with the following:

1. Leasing company which gives certificate of agreeing to lease equipment to the contractor.
2. Engineer in Charge, and
3. The contractor.

This advance shall further be subject to the condition that such plant and equipment (a) are considered by the Engineer-in-Charge to be necessary for the works; (b) and are in and are maintained in working order; (c) hypothecated to the BUIDCo as specified by the Engineer-in-Charge before the payment of advance is released. The contractor shall not be permitted to remove from the site such hypothecated plant and equipment without the prior written permission of the Engineer-in-Charge. The contractor shall be responsible for maintaining such plant and equipment in good working order during the entire period of hypothecation falling which such advance shall be entirely recovered in lump sum. For this purpose steel scaffolding and from work shall be treated as plant and equipment.

The contractor shall insure the Plant and Machinery for which mobilization advance is sought and given, for a sum sufficient to provide for their replacement at site. Any amounts not recovered from the insurer will be borne by the contractor.

Interest & Recovery

iv) The mobilization advance and plant and machinery advance in (ii)&(iii) above bear simple interest and should be equal to the prevailing rate of interest charged by the bank as mentioned in contract date schedule 'F' and shall be calculated from the date of payment to the date of recovery, both days inclusive, on the outstanding amount of advance. Recovery of such sums advanced shall be made by the deduction from the contractor's bills commencing after first ten per cent of the gross value of the work is executed and paid, on pro-rata percentage basis to the gross value of the work billed beyond 10% in such a way that the entire advance is recovered by the time eighty per cent of the gross value of the contract is executed and paid, together with interest due on the entire outstanding amount up to the date of the installment.

v) If the circumstances are considered reasonable by the Engineer-in-Charge, the period mentioned in (ii) and (iii) for request by the contractor in writing for grant of mobilization advance and plant and equipment advance may be extended in the discretion of the Chief General Manager.

vi) The said bank guarantee for advances shall initially be made for the full amount and valid for the contract period, and be kept renewed from time to time to cover the balance amount and likely period of complete recovery together with interest.

vii) Any materials including tools plants equipmentsetc brought to the site shall not be removed from the sites without the written permission of the Engineer-in-charge.

CLAUSE 10 C

Payment on Account of Increase in Prices/Wages due to Statutory Order(s)

If after submission of the tender the price of any material incorporated in the works (not being a material supplied from the Engineer-in-Charge's stores in accordance with clause 10 thereof) and/or wages of labour increases as a direct result of the coming into force of any fresh law, or statutory rule or order (but not due to any changes in sales tax) and such increase in the price and/or wages prevailing at the time of the last stipulated date for receipt of the tenders including extensions if any for the work, and the contractor thereupon necessarily and properly pays in respect of that material (incorporated in the works) such increased price and/or in respect of labour engaged on the execution of the work such increased wages, then the amount of the contract shall accordingly be varied and provided further that any such increase shall not be payable if such increase has become operative after the stipulated date of completion of the work in question.

If after submission of the tender, the price of any material incorporated in the works (not being a material supplied from the Engineer-in-Charge's stores in accordance with clause 10

thereof) and/or wages of labour is decreased as a direct result of the coming not force of any law or statutory rules or order (but not due to any changes in sales tax) and such decrease in the prices and/ or wages prevailing at the time of receipt of the tender for the work. The government shall in respect of materials incorporated in the works (not being materials supplied from the Engineer-in-Charge's stores in accordance with Clause-10 hereof) and/or labor engaged on the execution of the work after the date of coming into force of such law statutory rule or order be entitled to deduct from the dues of the contractor such amount as shall be equivalent to the difference between the prices of the materials and/or wages as prevailed at the time of the last stipulated date for receipt of tenders including extensions if any for the work and the price of materials and/or wages of labour on the coming into force of such law, statutory rule or order.

The contractor shall, for purpose of this condition, keep such books of account and other documents as are necessary to show the amount of any increase claimed or reduction available and shall allow inspection of the same by a duly authorised representative of BUIDCo, and further shall, at the request of the Engineer-in-Charge may require any documents so kept and such other information as the Engineer-in-Charge may require.

The contractor shall, within a reasonable time of his becoming aware of any alteration in the price of any such material and/or wages of labour, give notice thereof to the Engineer-in-Charge stating that the same is given pursuant to this condition together with all information relating thereto which he may be in position to supply.

CLAUSE 10 CA

Payment on Account of Increase/decrease in Prices of construction materials after receipt of tender.

If after submission of the tender, the price of cement or steel reinforcement bars / bitumen incorporated in the works (not being a material supplied from the Engineer-in-Charge's stores in accordance with Clause 10 thereof) increase(s) beyond the price(s) prevailing at the time of the last stipulated date for receipt of tenders (including extensions, if any) for the work, then the amount of the contract shall accordingly be varied and provided further that any such increase shall not be payable if such increase has become operative after the stipulated date of completion of work in question.

If after submission of the tender, the prices of cement and/or steel reinforcement bars / bitumen incorporated in the works (not being a material stipulated from the Engineer-in-Charge's stores in accordance with the Clause 10 thereof) is decreased, Government shall in respect of these materials incorporated in the works (not being materials supplied from the Engineer-in-Charge's stores in accordance with Clause 10 thereof) be entitled to deduct from the dues of the contractor such amount as shall be equivalent to the difference between the prices of Cement and/or Steel reinforcement bars/ bitumen as prevailed at the time of last stipulated date for receipt of tenders including extensions if any for the work and the prices of these materials on the coming into force of such base price of cement and/or steel reinforcement bars/ bitumen issued under authority of Schedule of Rate Committee.

The increase/decrease in prices shall be determined by the All India Wholesale Price Indices for Cement and Steel (bars and rods) as published by Economic Advisor to Government of India, Ministry of Commerce and Industry and base price for cement and/or steel reinforcement bars / bitumen as issued under authority of Schedule of Rate Committee as valid on the last stipulated date of receipt of tender, including extension if any and for the period under consideration.

The amount of the contract shall accordingly be varied for cement or steel reinforcement bars / bitumen and will be worked out as per the formula given below:-

Adjustment for cement component

(i) Price adjustment for increase or decrease in the cost of cement procured by the contractor shall be paid in accordance with the following formula:

$V_0 = 0.85 \times P_c / 100 \times R \times (C_1 - C_0)/C_0$

V_0 = increase or decrease in the cost of work during the month under consideration due to changes in rates for cement.

R = Value of the work.

C_0 = The all India wholesale price index for cement on 28 days preceding the date of opening of Bids as published by the Ministry of Industrial Development, Government of India, New Delhi.

C_1 = The all India average wholesale price index for cement for the month under consideration as published by Ministry of Industrial Development, Government of India, New Delhi.

P_c = Percentage of cement component of the work.

Adjustment for Steel component

(ii) Price adjustment for increase or decrease in the cost of steel procured by the Contractor shall be paid in accordance with the following formula:

$V_s = 0.85 \times P_s/100 \times R \times (S_1-S_0)/S_0$

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 (Bars and Rods) on 25 days preceding the date of opening of Bids as published by the Ministry o Industrial Development, Government of India New Delhi.

S_1 = The all India average wholesale price index for steel (Bars and Rods) for the month under consideration as published by Ministry of Industrial Development, New Delhi.

P_s = Percentage of Steel component of the work.

Note : For the application of this clause, index of Bars and Rods has been chosen to represent steel group.

Adjustment for M.S. /G.I. Pipes and Fittings Component

$$Vs = 0.85 \times \frac{P_{GI}}{100} \times R \frac{(S1-S0)}{So}$$

Vs = Increase or decrease in cost of work during the Month under consideration due to changes in the rates of pig iron

P_{GI} = Percentage of G.I. component of the work.

R = Value of the work.

S1 = Rate of HR Coil / plate for the month under consideration as issued by SAIL.

S0 = Rate of HR Coil / plate on 25 days preceding the date of opening of Bids as issued by SAIL

CLAUSE 10 CC (Deleted)

Payment due to increase / Decrease in Prices / Wages after receipt of tender (Time of completion more than 18 months)

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 upto 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) Following expressions and meanings are assigned 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.

(c) 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 clauses 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.

The formula (e) for adjustment of prices are:

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:

$V_L = 0.85 \times P_1/100 \times R \times (L_1 - L_0)/L_0$

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 date of opening of Bids as published by Labour Bureau, Ministry of Labour, Government of India.

L_1 = The consumer price index for industrial workers for the State for the under consideration as published by Labour Bureau, Ministry of Labour, Government of India.

P_1 = Percentage of labour component of the work.

Adjustment for cement component

(ii) Price adjustment for increase or decrease in the cost of cement procured by the contractor shall be paid in accordance with the following formula:

$V_0 = 0.85 \times P_0/100 \times R \times (C_1 - C_0)/C_0$

V_0 = 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 cement on 28 days preceding the date of opening of Bids as published by the Ministry of Industrial Development, Government of India, New Delhi.

C_1 = The all India average wholesale price index for cement for the month under consideration as published by Ministry of Industrial Development, Government of India, New Delhi.

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:

$V_s = 0.85 \times P_s/100 \times R \times (S_1 - S_0)/S_0$

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 (Bars and Rods) on 25 days preceding the date of opening of Bids as published by the Ministry o Industrial Development, Government of India New Delhi.

S_1 = The all India average wholesale price index for steel (Bars and Rods) for the month under consideration as published by Ministry of Industrial Development, New Delhi.

P_1 = Percentage of labour component of the work.

Note : For the application of this clause, index of Bars and Rods has been chosen to represent steel group.

Adjustment of POL (fuel and lubricant) component

(v) Price adjustment for increase or decrease in the cost of POL (fuel and lubricant) shall be paid in accordance with the following formula.

$V_f = 0.85 \times P_f/100 \times R \times (F_1-F_0)/F_0$

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 nearest center on the day 28 days prior to the date of opening of Bids.

F_1 = The official retail price of HSD at the existing consumer pumps of IOC at nearest center for the 15^{th} day of month of the under consideration.

P_1 = 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 fuel and lubricants group.

Adjustment for Plant and Machinery Spares component

(vi) Price adjustment for increase or decrease in the cost of plant and machinery spares procured by the Contractor shall be paid in accordance with the following formula :

$V_p = 0.85 \times P_p/100 \times R \times (P_1-P_0)/P_0$

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 heavy machinery and parts on 28 days preceding the date of opening of Bids as published by the Ministry of Industrial Development Government of India, New Delhi.

P_1 = The all India average wholesale price index for heavy machinery and parts for the month under consideration as published by Ministry of Industrial Development, Government of India, New Delhi.

P_1 = 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 for M.S./G.I. Pipes and Fittings Component

(ix)

$$Vs = 0.85 \times \frac{P_{GI}}{100} \times R \frac{(S1-S0)}{So}$$

Vs = Increase or decrease in cost of work during the Month under consideration due to changes in the rates of pig iron

P_{GI} = Percentage of G.I. component of the work.

R = Value of the work.

S1 = Rate of HR Coil / plate for the month under consideration as issued by SAIL.

S_0 = Rate of HR Coil / plate on 25 days preceding the date of opening of Bids as issued by SAIL

Adjustment of other materials component

(vii) 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:

$V_m = 0.85 \times P_m/100 \times R \times (M_1-M_0)/M_0$

V_m = Increase or decrease in the cost of work during the month under consideration due to changes 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 date of opening of Bids, as published by the Ministry of Industrial Development, Government of India, New Delhi.

M_1 = The all India wholesale price index (all commodities) for the month under consideration as published by Ministry of Industrial Development, Government of India, New Delhi.

P_1 = Percentage of local material component (other than cement, steel, bitumen and POL) of the work.

The following percentages will govern the price adjustment for the entire contract:

1.	Labour - P_1	25 %
2.	Cement – P_c	10 %
3.	Steel – P_s	10 %
4.	POL – P_f	5 %
5.	Plant & Machinery Spares – P_p	5 %
6.	Other materials – P_m	45 %
	Total	100%

An example

(viii) In contract where clause 10CA is applicable, this clause 10CC will not be applicable and in contract where this clause 10CC is applicable previous clause 10CA will not be applicable.

CLAUSE 10 D

Dismantled Material Govt. Property

The contractor shall treat all materials obtained during dismantling of a structure, excavation of the site for a work, etc. as Government's property and such materials shall be disposed off to the best advantage of Government according to the PWD codal provision.

CLAUSE 11

Work to be Executed in Accordance with Specifications, Drawings, Orders etc.

The contractor shall execute the whole and every part of the work in the most substantial and workmanlike manner both as regards materials and otherwise in every respect in strict accordance with the specifications. The contractor shall also conform exactly, fully and faithfully to the design, drawings and instructions in writing in respect of the work signed by the Engineer-in-Charge and the contractor shall be furnished free of charge one copy of the contract documents together with specification, designs, drawings and instruction as are not included in the standard specifications of Public Works Department specified in Schedule 'F' or in any Bureau of Indian Standard or any other, published standard or code or, Schedule of Rates or any other printed publication referred to elsewhere in the contract.

The contractor shall comply with the provisions of the contract and with the care and diligence execute and maintain the works and provide all labour and materials, tools and plants including for measurements and supervision of all works, structural plans and other things of temporary or permanent nature required for such execution and maintenance in so far as the necessity for providing these, is specified or is reasonably inferred from the contract. The Contractor shall take full responsibility for adequacy, suitability and safety of all the works and methods of construction.

CLAUSE 12

Deviations/ Variations Extent and Pricing

The Engineer-in-Charge (As per codal provision) shall have power (i) to make alternation in, omissions from, additions to, or substitutions for the original specifications, drawings, designs and instructions that may appear to him to be necessary or advisable during the progress of the work, and (ii) to omit a part of the works in case of non-availability of a portion of the site or for any other reasons and the contractor shall be bound to carry out the works in accordance with any instructions given to him in writing signed by the Engineer-in-Charge

after approval from competent authority and such alterations omissions, additions or substitutions shall form part of the contract as if originally provided therein and any altered, additional or substituted work which the contractor may be directed to do in the manner specified above as part of the works, shall be carried out by the contractor on the same conditions in all respects including price on which he agreed to do the main work except as hereafter provided.

12.1 The time for completion of the works shall, in the event of any deviations resulting in additional cost over the tendered value sum being ordered be extended, if requested by the contractor, as follows:

i) In the proportion which the additional cost of the altered, additional or substituted work, bears to the original tendered value plus.

ii) 25% of the time calculated in (i) above or such further additional time as may be considered reasonable by the Engineer-in-Charge after approval from competent authority

Deviation, Extra items and Pricing

12.2 In the case of extra item(s) the contractor may within fifteen days of receipt of order or occurrence of the item(s) claim rates, supported by proper analysis, for the work and the Engineer-in-Charge after approval from competent authority shall within one month of the receipt of the claims supported by analysis, after giving consideration to the analysis of the rates submitted by the contractor, determine the rates as per power delegated in PWD Code and on the basis of the market rates and the contractor shall be paid in accordance with the rates so determined.

Deviation, Substituted Items, Pricing

In the case of substituted items, the rate for the agreement item (to be substituted) and substituted item shall also be determined in the manner as mentioned in the aforesaid para.

(a) If the market rate for the substituted item so determined is more than the market rate of the agreement item (to be substituted) the rate payable to the contractor for the substituted item shall be the rate for the agreement item (to be substituted) so increased to the extent of the difference between the market rates of substituted item and the agreement item (to be substituted).

(b) If the market rate for the substituted item so determined is less than the market rate of the agreement item (to be substituted) the rate payable to the contractor for the substituted item shall be the rate for the agreement item (to be substituted) so decreased to the extent of the difference between the market rates of substituted item and the agreement item (to be substituted).

Deviation, Deviated Quantities, Pricing

In the case of contract items, substituted items, contract cum substituted items, which exceed the limits laid down in Schedule F, the contractor may within fifteen days of receipt of order or occurrence of the excess, claim revision of the rates, supported by proper analysis, for the work in excess of the above mentioned limits, provided that if the rates so claimed are in excess of the rates specified in the schedule of quantities the Engineer-in-Charge shall within one month of receipt of the claims supported by analysis, after giving consideration to the analysis of the rates submitted by the contractor, determine the rates as per power delegated in PWD Code and on the basis of the market rates and the contractor shall be paid in accordance with the rates so determined.

12.3 The provisions of the preceding paragraph shall also apply to the decrease in the rates of items for the work in excess of the limits laid down in Schedule 'F' and the Engineer-in-Charge shall after giving notice to the contractor within one month of occurrence of the excess and after taking into consideration any reply received from him within fifteen days of receipt of the notice, revise the rates as per power delegated in PWD Code for the work in question within one month of expiry of the said period of fifteen days having regard to the market rates or current schedule of rate.

12.4 The contractor shall send to the Engineer-in-Charge once every three months an up to date account giving complete details of all claims for additional payments to which the contractor may consider himself entitled and of all additional work ordered by the Engineer-in-Charge after approval from competent authority which he has executed during the preceding quarter

failing which the contractor shall be deemed to have waived his right. However, the General Manager (Works) is authorized for consideration of such claims on merits.

12.5 For the purpose of operation of Schedule 'F' the following works shall be treated as works relating to foundation:

i) For buildings, compound walls plinth level or 1.2 meters (4 feet) above ground level whichever is lower excluding items of flooring and D.P.C. but including base concrete below the floors.

ii) For abutments, piers, retaining walls of culverts and bridges, walls of water reservoirs the bed of floor level.

iii) For retaining walls where floor level is not determinate 1.2 meters above the average ground level or bed level.

iv) For Roads all items of excavation and filling including treatment of sub-base.

12.6 Any operation incidental to or necessary has to be in contemplation of tenderer while filing tender, or necessary for proper execution of the item included in the Schedule of quantities or in the schedule of rates mentioned above, whether or not, specifically indicated in the description of the item and the relevant specifications, shall be deemed to be included in the rates quoted by the tenderer or the rate given in the said schedule of rates, as the case may be. Nothing extra shall be admissible for such operations.

CLAUSE 13

Foreclosure of Contract due to Abandonment or Reduction in Scope of Work

If at any time after acceptance of the tender Government shall decide to abandon or reduce the scope of the works for any reason whatsoever and hence not require the whole or any part of the works to be carried out, the Engineer-in-Charge shall give notice in writing to that effect to the contractor and the contractor shall act accordingly in the matter. The contractor shall have no claim to any payment of compensation or otherwise whatsoever, on account of any profit or advantage which he might have derived from the execution of the works in full but which he did not derive in consequence of the foreclosure of the whole or part of the works.

The contractor shall be paid at contract rates for works executed at site only.

CLAUSE 14

Cancellation of contract in full or part

If the contractor:

i) at any time makes default in proceeding with the works or any part of the work with due diligence and continues to do so after a notice in writing of 7 days from the Engineer-in-Charge; or

ii) Commits default to comply with any of the terms and conditions of the contract and does not remedy it or take effective steps to remedy it within 7 days after a notice in writing is given to him in that behalf by the Engineer-in-Charge; or

iii) Fails to complete the works or items of work with individual dates of completion, on or before the date(s) of completion, and does not complete them within the period specified in a notice given in writing in that behalf by the Engineer-in-Charge; or

iv) Shall offer or give or agree to give to any person in Government service or to any other person on his behalf any gift or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of this or any other contract for Government; or

v) Shall enter into a contract with Government/ BUIDCo in connection with which commission has been paid or agreed to be paid by him or to his knowledge, unless the particulars of any such commission and the terms of payment thereof have been previously disclosed in writing to the Accepting Authority/Engineer-in-Charge; or

vi) Shall obtain a contract with Government / BUIDCo as a result of wrong tendering or other non-bonafide methods of competitive tendering; or

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

viii) Being a company, shall pass a resolution or the Court shall make an order for the winding up of the company, or a receiver or manager on behalf of the debenture holders or otherwise shall be appointed or circumstances shall arise which entitle the Court or debenture holders to appoint a receiver or manager; or

ix) Shall suffer an execution being levied on his goods and allow it to be continued for a period of 21 days; or

x) Assigns, transfers, sublets (engagement of labour on a piece-work basis or of labour with materials not to be incorporated in the work, shall not be deemed to be subletting) or otherwise parts with or attempts to assign, transfer sublet or otherwise parts with the entire works or any portion thereof without the prior written approval of the Competent Authority;

The Competent Authority may, without prejudice to any other right or remedy which shall have accrued or shall accrue hereafter to Government, by a notice in writing to cancel the contract as a whole or only such items of work in default from the Contract.

The Engineer-in-Charge shall on such cancellation by the Competent Authority have powers to :

(a) Take possession of the site and any materials, constructional plant, implements stores, etc., thereon; and/or

(b) Carry out the incomplete work by any means at the risk and cost of the contractor.

On cancellation of the contract in full or in part, the Engineer-in-Charge shall determine what amount, if any, is recoverable from the contractor for completion of the works or part of the works or in case the works or part of the works is not to be completed, the loss of damage suffered by Government. In determining the amount, credit shall be given to the contractor for the value of the work executed by him up to the time of cancellation, the value of contractor's materials taken over and incorporated in the work and use of plant and machinery belonging to the contractor.

Any excess expenditure incurred or to be incurred by BUIDCo in completing the works or part of the works or the excess loss or damages suffered or which may be suffered by BUIDCo as aforesaid after allowing such credit shall without prejudice to any other right or remedy available to BUIDCo in law be recovered from any moneys due to the contractor on any account, and if such moneys are not sufficient the contractor shall be called upon in writing and shall be liable to pay the same within 31 days.

If the contractor fails to pay the required sum within the aforesaid period of 30 days the Engineer-in-Charge shall have the right to sell any or all of the contractors unused materials, constructional plant, implements, temporary buildings, etc. and apply the proceeds of sale thereof towards the satisfaction of any sums due from the contractor under the contract and if thereafter there be any balance is outstanding from the contractor, it shall be recovered in accordance with the provisions of the contract.

Any sums in excess of the amounts due to BUIDCo and unsold materials, constructional plant, etc., shall be returned to the contractor, provided always that if cost or anticipated cost of completion by BUIDCo of the works or part of the works is less than the amount which the contractor would have been paid had he completed the works or part of the works, such benefit shall not accrue to the contractor.

CLAUSE 15

Suspension of Work

i) The contractor shall, on receipt of the order in writing of the Engineer-in-Charge (whose decision shall be final and binding on the contractor) suspend the progress of the works or any part thereof for such time and in such manner as the Engineer-in-Charge may consider necessary so as not to cause any damage or injury to the work already done or endanger the safety thereof, for any of the following reasons :

a) on account of any default on the part of the contractor or;

b) for proper execution of the works or part thereof for reasons other than the default of the contractor; or

c) for safety of the works or part thereof.

The contractor shall, during such suspension, properly protect and secure the works to the extent necessary and carry out the instructions given in that behalf by the Engineer-in-Charge.

ii) If the suspension is ordered for reasons (b) and (c) in sub-para (i) above, the contractor shall be entitled to an extension of time equal to the period of every such suspension PLUS 25%, for completion of the item or group of items of work for which a separate period of completion is specified in the contract and of which the suspended work forms a part, and;

CLAUSE 16

Action in case Work not done as per Specifications

All works under or in course of execution or executed in pursuance of the contract shall at all times be open and accessible to the inspection and supervision of the Engineer-in-Charge, his authorized subordinates in charge of the work and all the superior officers, officer of the Quality Control Organization of the Department and of the Cabinet (Technical) Vigilance, and the contractor shall, at all times, during the usual working hours and at all other times at which reasonable notice of the visit of such officers has been given to the contractor, either himself be present to receive orders and instructions of have a responsible agent duly accredited in writing, present for that purpose. Orders given to the Contractor's agent shall be considered to have the same force as if they had been given to the contractor himself.

If it shall appear to the Engineer-in-Charge or his higher authority or his authorised subordinates in charge of the work or to the Cabinet (Technical) Vigilance or his subordinate officers, that any work has been executed with unsound, imperfect, or unskillful workmanship, or with materials or article provides by him for the execution of the work which are unsound or of a quality inferior to that contracted or otherwise not in accordance with the contract the contractor shall, on demand in writing which shall be made within the period specified in schedule – F of contract data from the Engineer-in-Charge specifying the work, materials or articles complained of notwithstanding that the same may have been passed, certified and paid for forthwith rectify, or remove and reconstruct the work so specified in whole or in part, as the case may require or as the case may be, remove the materials or articles so specified and provide other proper and suitable materials or articles at his own charge and cost. In the event of the contractor failing do so within a period specified by the Engineer-in-Charge in his demand aforesaid, then the contractor shall be liable to pay compensation at the same rate as under clause 2 of the contract (for non-completion of the work in time) for this default.

In such case the Engineer-in-Charge may not accept the item of work at the rates applicable under the contract but may accept such items at reduced rates as the competent authority may consider reasonable during the preparation of on account bills or final bill if the item is so acceptable without detriment to the safety and utility of the item and the structure and incidental items rectified, or removed and re-executed at the risk and cost or contractor. Decision of the Engineer-in-Charge to be conveyed in writing in respect of the same will be final and binding on the contractor.

CLAUSE 17

Contractor Liable for Damages, defects during maintenance period

If the contractor or his working people or servants shall break, deface, injure or destroy any part of building in which they may be working, or any building, road, road curb, fence, enclosure, water pipe, cables, drains, electric or telephone post or wired, trees, grass or grassland, or cultivated ground contiguous to the premises on which the work or any part is being executed, or if any damage shall happen to the work while in progress, from any cause whatever or if any defect, shrinkage or other faults appear in the work within defect liability period after a certificate final or otherwise of its completion shall have been given by the Engineer-in-Charge as aforesaid arising out of defect or improper materials or workmanship the contractor shall upon receipt of a notice in writing on that behalf make the same good at his own expense or in default the Engineer-in-Charge cause the same to be made good by other workmen and deduct the expense from any sums that may be due or at any time thereafter may become due to the contractor, or from his security deposit except for the portion pertaining to asphaltic work which is governed by sub-para (iii) of clause 35 or the proceeds of sale thereof or of a sufficient option thereof. The security deposit of the contractor shall not be refunded before the expiry of defected liability period after the issue of the certificate final or otherwise, of completion of work, or till the final bill has been prepared and passed whichever is later.

In case of Maintenance and Operation works of Electrical & Mechanical services, the security deposit deducted from contractors shall be refunded within one month from the date of final payment or within one month from the date of completion of the maintenance contract whichever is earlier.

CLAUSE 18

Contractor to Supply Tools & Plants etc.

The contractor shall provide at his own cost all materials (except such special materials, if any, as may in accordance with the contract be supplied from the Engineer-in-Charge's stores), plant, tools, appliances, implements, ladders, cordage, tackle, scaffolding and temporary works required for the proper execution of the work, whether original, altered or substituted and whether included in the specification or other document forming part of the contract or referred to in these conditions or not, or which may be necessary for the purpose of satisfying or complying with the requirements of the Engineer-in-Charge as to any matter as to which under these conditions he is entitled to be satisfied, or which he is entitled to require together with carriage therefore to and from the work. The contractor shall also supply without charge the requisite number of persons with the means and materials, necessary for the purpose of setting out works, and counting, weighing and assisting the measurement for examination at any time and from time to time of the work or materials. Failing his so doing the same may be provided by the Engineer-in-Charge at cost to the contractor, under this contract or otherwise and/or from his security deposit or the proceeds of sale thereof, or of a sufficient portions thereof.

CLAUSE 18 A

Recovery of Compensation paid to Workman

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

CLUASE 18 B

Ensuring Payment and Amenities to Workers if Contractor fails

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

CLAUSE 19

Labour Laws to be complied by the Contractor

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

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

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

The bidder should be registered in EPF.

The bidder should submit the Project Insurance and professional liability insurance documents after award of the contract.

CLAUSE 19 A

No labour below the prescribed age shall be employed on the work.

CLAUSE 19 B

Payment of Wages

Payment of wages :

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

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

iii) In respect of all labour directly or indirectly employed in the works for performance of the contractor's part of this contract, the contractor shall comply with or cause to be complied with the Public Works Department contractor's Labour Regulations made by Government from time to time in regard to payment of wages, wage period, deductions from wages recovery of wages not paid and deductions unauthorisedly made, maintenance of wage books or wage slips, publication of scale of wages and other terms of employment, inspection and submission of

periodical returns and all other matters of the like nature or as per the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and the Contract Labour (Regulation And Abolition) Central Rules, 1971, wherever applicable.

iv) a) The Engineer-in-Charge concerned shall have the right to deduct from the moneys due to the contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers by reason of nonfulfillment of the conditions of the contract for the benefit of the workers, non-payment of wages or of deductions made from his or their wages which are not justified by their terms of the contract or non-observance of the Regulations.

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

v) The contractor shall comply with the provisions of the Payment of Wages Act, 1936, Minimum Wages Act, 1948, Employees Liability Act, 1938, Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Act, 1970, or the modifications thereof or any other laws relating thereto and the rules made hereunder from time to time.

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

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

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

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

CLAUSE 19 C

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

CLAUSE 20

Minimum wages Act to be complied with.

The contractor shall at least pay and comply with all the provisions of the Minimum wages Act s and rules framed there under other labour laws related to contract labour .

CLAUSE 21

Work not to be sublet. Action in case of insolvency

The contract shall not be assigned or sublet without the written approval of the Engineer-in-Charge. And if the contractor shall assign or sublet his contract, or attempt to do so, or

become insolvent or commence any insolvency proceedings or make any composition with his creditors or attempt to do so, or if any bribe, gratuity, gift, loan, perquisite, reward or advantage pecuniary or otherwise, shall either directly or indirectly, be given, promised or offered by the contractor, or any of his servants or agent to any public officer or person in the employment of BUIDCo in any way relating to his office or employment, or if any such officer or person shall become in any way directly or indirectly interested in the contract, the Engineer-in-Charge on behalf of the Governor of Bihar shall have power to adopt the courses specified in Clause 3 hereof in the interest of BUIDCo and in the event of such course being adopted the consequences specified in the said Clause 3 shall ensue.

CLAUSE 22

Compensation

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

CLUASE 23

Changes in firm's Constitution to be intimated

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

CLAUSE 24

Approval of Engineer In charge

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

CLAUSE 25

Settlement of Disputes & Arbitration

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

i) If the contractor considered any work demanded of him to be outside the requirements of the contract, or dispute any drawings, record or decision given in writing by the Engineer-in-Charge on any matter in connection with or arising out of the contract or carrying out of the contract or carrying out of the work, to be unacceptable, he shall promptly within 7 days request the General Manager(Works), BUIDCo in writing for written instruction or decision. Thereupon, the General Manager(Works), BUIDCo shall give his written instructions or decision within a period of fifteen days from the receipt of the contractor's letter.

If the General Manager(Works), BUIDCo fails to give his instructions or decision in writing within the aforesaid period or if the contractor is dissatisfied with the instructions or decision of the General Manager(Works),BUIDCo the contractor may, within 15 days of the receipt of General Manager(Works)'s decision, appeal to the Chief General Manager, BUIDCo who shall afford an opportunity to the contractor to be heard, if the latter so desires, and to offer evidence in support of his appeal. The Chief General Manager, BUIDCo shall give his decision within 30 days of receipt of contractor's appeal. If the contractor is dissatisfied with this decision, the contractor shall within a

period of 30 days from receipt of the decision, give notice to the Chief General Manager, for reference of the same to arbitration tribunal failing which the said decision shall be final binding and conclusive and not referable to adjudication by the arbitrator.

ii) Except where the decision has become final, binding and conclusive in terms of Sub Para (i) above disputes or difference shall be referred for adjudication through Arbitration Tribunal already established by the state government under Bihar Public Work Contract Disputes Arbitrational Tribunal Act 2008.

It is also a term of this contract that if the contractor does not make any reference to the arbitration Tribunal in respect of any claims in writing as aforesaid within 45 days of receiving the intimation from the Engineer-in-Charge that the final bill is ready for payment, the claim of the contractor shall be deemed to have been waived and absolutely barred and the BUIDCo shall be discharged and released of all liabilities under the contract in respect of these claims.

The arbitration shall be conducted in accordance with the provisions of the Bihar Public works contract Dispute Arbitration Tribunal Act 2008 or any statutory modifications or re-enactment thereof and the rules made there under and for the time being in force shall apply to the arbitration proceeding under this clause.

All arbitration shall be held at PATNA and at no other place.

CLAUSE 26

Contractor to indemnity Govt. against Patent Rights

The contractor shall fully indemnify and deep indemnified the Governor of Bihar against any action, claim or proceeding relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any article or part thereof included in the contract. In the event of any claims made under the action brought against Government in respect of any such matter as aforesaid the contractor shall be immediately notified thereof and the contractor shall be at liberty, at his own expense, to settle any dispute or to conduct any litigation that may arise therefrom, provided that the contractor shall not be liable to indemnify the Governor of Bihar if the infringement of the patent or design or any alleged patent or design right is the direct result of an order passed by the Engineer-in-Charge in this behalf.

CLAUSE 27

Lumpsum Provisions in Tender

When the estimate on which a tender is made includes lump sum in respect of parts of the work, the contractor shall be entitled to payment in respect of the items of work involved or the part of the work in question at the same rates as are payable under this contract for such items, or if the part of the work in question is not, in the opinion of the Engineer-in-Charge capable of measurement, The Engineer-in-Charge may at his discretion pay the lump-sum amount entered in the estimate, and the certificate in writing of the Engineer-in-Charge shall be final and conclusive against the contractor with regard to any sum or sums payable to him under the provisions of the clause.

CLAUSE 28

Action where no Specifications are specified

In the case of any class of work for which there is no such specifications as referred to in Clause 11, such work shall be carried out in accordance with the Bureau of Indian Standards Specifications, Indian Road Congress for road works and Indian Building Congress for building works or any central government agency. In case there are no such specifications in Bureau of Indian Standards, the work shall be carried out as per manufacturers specifications. If not available, then as per Department Specifications. In case there are no such specifications as required above, the work shall be carried out in all respects in accordance with the instructions and requirements of the Engineer-in-Charge.

CLAUSE 29

With-holding and lien in respect of sums due from contractor

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

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

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

CLAUSE 29 A

Lien in respect of claims in other Contracts

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

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

or damages whatsoever on this account or on any other ground in respect of any sum of money withheld or retained under this clause and duly notified as such to the contractor.

CLAUSE 30

Unfiltered water supply

The contractor(s) shall make his/their own arrangements for water required for the work and nothing extra will be paid for the same. This will be subject to the following conditions.

i) That the water used by the contractor(s) shall be fit for construction purposes to the satisfaction of the Engineer-in-Charge.

ii) The Engineer-in-Charge shall make alternative arrangements for supply of water at the risk and cost of contractor? (s) if the arrangements made by the contractor(s) for procurement of water are in the opinion of the Engineer-in-Charge, unsatisfactory.

CLAUSE 31

Return of surplus material

Notwithstanding anything contained to the contrary in this contract, where any materials for the execution of the contract are procured with the assistance of BUIDCo either by issue from BUIDCo stocks or purchase made under orders or permits or licenses issued by BUIDCo the contractor shall hold the said materials economically and solely for the purpose of the contract and not dispose of them without the written permission of the BUIDCo and return, if required by the Engineer in Charge, all surplus or unserviceable materials that may be left with him after the completion of the contract or at its termination for any reason whatsoever on being paid or credited such price as the Engineer in Charge shall determine having due regard to the condition of the materials. The price allowed to the contractor however shall not exceed the amount charged to him excluding the element of storage charges. The decision of the Engineer in Charge shall be final and conclusive. In the event of breach of the aforesaid condition the contractor shall in addition to throwing himself open to action for contravention of the term of the license or permit and/or for criminal breach of trust, be liable to BUIDCo for all moneys, advantages or profits resulting or which in the usual course would have resulted to him by reason of such breach.

CLAUSE 32

Hire of Plant & Machinery

i) The contractor shall arrange at his own expense all tools, plant machinery and equipment (hereinafter referred to as T & P) required for execution of the work except for the Plant & Machinery listed in Schedule 'C' and stipulated for issue to the contractor. If the contractor requires any item of T & P on hire from the T & P available will, if such item is available, hire it to the contractor at rates to be agreed upon between him and the Engineer-in-Charge. In such a case all the conditions hereunder for issue of T & P shall also be applicable to such T & P as is agreed to be issued.

ii) Plant and Machinery when supplied on hire charges shown in Schedule 'C' shall be made over and taken back at the departmental equipment yard/shed shown in Schedule 'C' and the contractor shall bear the cost of carriage from the place of issue to the site of work and back. The contractor shall be responsible to return the plant and machinery in the condition in which it was handed over to him, and he shall be responsible for all damage caused to the said plant and machinery at the site of work or elsewhere in operation and otherwise during transit including damage to or loss of plant and for all losses due to his failure to return the same soon after the completion of the work for which it was issued. The Project Director shall be the sole judge to determine the liability of the contractor and its extent in this regard and his decision shall be final and binding on the contractor.

iii) The plant and machinery as stipulated above will be issued as and when available and if required by the contractor. The contractor shall arrange his programme of work according to the availability of the plant and machinery and no claim, whatsoever, will be entertained from him for any delay in supply by the Department.

iv) The hire charges shall be recovered at the prescribed rates from and inclusive of the date the plant and machinery made over up to and inclusive of the date of the return in good order even though the same may not have been working for any cause except major breakdown due to no fault of the contractor or faulty use requiring more than three working days continuously (excluding intervening holidays and Sundays) for bringing the plant in order. The contractor shall immediately intimate in writing to the Engineer in Charge when any plant or machinery gets out of order requiring major repairs as aforesaid. The Engineer in Charge shall record the date and time of receipt of such intimation in the log sheet of the plant or machinery. Based on this if the breakdown occurs before lunch period or major breakdown will be computed considering half a day's breakdown on the day of complaint. If the breakdown occurs in the post lunch period of major breakdown will be computed starting from the next working day. In case of any dispute under this clause the decision of the General Manager (Works) shall be final and binding on the contractor.

v) The hire charges shown above are for each day of 8 hours (inclusive of the one-hour lunch break) or part thereof.

vi) Hire charges will include service of operating staff as required and also supply of lubricating oil and stores for cleaning purposes. Power fuel of approved type, firewood, kerosene oil etc. for running the plant and machinery and also the full time chowkidar for guarding the plant and machinery against any loss or damage shall be arranged by the contractor who shall be fully responsible for the safeguard and security of plant and machinery. The contractor shall on or before the supply of plant and machinery sign an agreement indemnifying BUIDCo against any loss or damage caused to the plant and machinery either during transit or at site of work.

vii) Ordinarily, no plant and machinery shall work for more than 8 hours a day inclusive of one hour lunch break. In case of an urgent work however, the Engineer in Charge may, at his discretion, allow the plant and machinery to be worked for more than normal period or 8 hours a day. In that case the hourly hire charges for overtime to charge $(1/8)^{th}$ of the daily charges) subject to a minimum of half day's normal charges on any particular day. For working out hire charges for over time a period of half an hour and above will be charged as one hour and a period of less than half an hour will be ignored.

viii) The contractor shall release the plant and machinery every seventh day for periodical servicing and/or wash out which may take about three to four hours or more. Hire charges for full day shall be recovered from the contractor for the day of servicing/Wash out irrespective of the period employed in servicing.

ix) The plant and machinery once issued to the contractor shall not be returned by him on account of lack of arrangements of labour and materials, etc. on his part, the same will be returned only when they are required for major repairs or when in the opinion of the Engineer in Charge the work or a portion of work for which the same was issued is completed.

x) Logbook for recording the hours of daily work for each of the plant and machinery supplied to the contractor will be maintained by the Department and will be countersigned by the contractor or his authorised agent daily. In case the contractor contests the correctness of the entries and/or fails to sign the Log Book the decision of the Engineer in Charge shall be final and binding on him. Hire charges will be calculated according to the entries in the Logbook and will be binding on the contractor. Recovery on account of hire charges for road rollers shall be made for the minimum number of days worked out on the assumption that a roller can consolidate per day and maximum quantity of materials or area surfacing as noted against each in the annexed statement (see attached annexure).

xi) In the case of concrete mixers, the contractors shall arrange to get the hopper cleaned and the drum washed at the close of the work each day or each occasion.

a) In case rollers for consolidation are employed by the contractor himself, log book for such rollers shall be maintained in the same manner as is done in case of

departmental rollers, maximum quantity of any item to be consolidated for each roller day shall also be same as in Annexure to Clause 34(x). For less use of rollers recovery for the less roller days shall be made at the stipulated issue rate.

xii) The contractor shall be responsible to return the plant and machinery in the condition in which it was handed over to him and he shall be responsible for all damage caused to the said plant and machinery at the site of work or elsewhere in operation or otherwise or during transit including damage to or loss of parts, and for all losses due to him failure to return the same soon after the completion of the work for which it was issued. The Project Director shall be the sole judge to determine the liability of the contractor and its extent in this regard and his decision shall be final and binding on the contractor.

xiii) The contractor will be exempted for levy of any hire charges for the number of days he is called upon in writing by the Engineer in Charge to suspend execution of the work provided by BUIDCo plant and machinery in question have, in fact remained idle with the contractor because of the suspension.

xiv) In the event of the contractor not requiring any item of plant and machinery issued by BUIDCo though not stipulated for issue in Schedule 'C' any time after taking delivery at the place of issue, he may return it after two days written notice or at any time without notice if he agrees to pay hire charges for two additional days without in any way affecting the right of the Engineer in-Charge to use the said plant and machinery during the said period of two days as he likes including hiring out to a third party.

CLAUSE 33

Contractors Superintendence, Supervision, Technical Staff & Employees

Employment of Technical Staff and employees

i) The contractor shall provide all necessary superintendence during execution of the work and as along thereafter as may be necessary for proper fulfilling of the obligations under the contract.

The contractor along with bidding of the tender, intimate in writing to the Engineer-in-Charge the name, qualifications, experience, age, address and other particulars along with certificates, of the technical representative to be in charge of the work. If there is any change then the new incumbents qualifications and experience shall not be lower than specified in Schedule in I.T.B. (Annexure – 2). The Engineer-in-Charge shall within 15 days of issue of letter of acceptance intimate in writing his approval or otherwise it is deemed to be approved. Any such approval may at any time be withdrawn and in case of such withdrawal the contractor shall appoint another such representative according to the provisions of this clause. Decision of the tender accepting authority / General Manager (Works) shall be final and binding on the contractor in this respect. Technical staff shall be available at site within fifteen days of start of work.

If the contractor (or any partner in case of firm/company) himself has such qualifications, it will not be necessary for the said contractor to appoint such a principal technical representative but the contractor shall designate and appoint a responsible agent to represent him and to be present at the work whenever the contractor is not in a position to be so present. All the provisions applicable to the principal technical representative under the Clause will also be applicable in such a case to contractor or his responsible agent. The principal technical representative and/or the contractor or his responsible authorised agent shall be actually available at site at least two working days every week, these days shall be determined in advance and also during recording of measurement of works and whenever so required by the Engineer-in-Charge by a notice as aforesaid and shall also note down instructions conveyed by the Engineer-in-Charge or his designated representative in the site order book and in token of acceptance of measurements. There shall be no objection if the representative/agent looks after more than one work and not more than three works in the same station provided these details are disclosed to the Engineer-in-Charge and he shall be satisfied that the provisions and the purpose of the clause are fulfilled satisfactorily.

If the Engineer-in-Charge, whose decision in this respect is final and binding on the contractor, is convinced that no such technical representative or agent is effectively appointed or is effectively attending or fulfilling the provision of this clause, a recovery shall be effected from the contractor as specified in Schedule 'F' and the decision of the Engineer-in-Charge as recorded in the site order book and measurement recorded in Measurement Books shall be final and binding on the contractor. Further if the contractor fails to appoint a suitable technical representative or responsible agent and if such appointed persons are not effectively present or do not discharge their responsibilities satisfactorily, the Engineer-in-Charge shall have full powers to suspend the execution of the work until such date as a suitable agent is appointed and the contractor shall submit a certificate of employment of the technical representative/responsible agent along with every on account bill/fixed bill and shall produce evidence if at any time so required by the Engineer-in-Charge.

ii) The contractor shall provide and employ on the site only such technical assistants as are skilled and experienced in their respective fields and such foremen and supervisory staff as are competent to give proper supervision to the work.

The contractor shall provide and employ skilled, semiskilled and unskilled labour as is necessary for proper and timely execution of the work.

The Engineer in Charge shall be at liberty to object to and require the contractor to remove from the works any person who in his opinion misconducts himself, or is incompetent or negligent in the performance of his duties or whose employment is otherwise considered by the Engineer in Charge to be undesirable. Such person shall not be employed again at works site without the written permission of the Engineer in Charge and the persons so removed shall be replaced as soon as possible by competent substitutes.

CLAUSE 34

Levy/Taxes payable by Contractor

i) Sales Tax or any other tax on materials in respect of this contract shall be payable by the contractor according to law in effect.

ii) The contractor shall deposit royalty and obtain necessary permit for supply of the red earth, moorum, sand chips bajri, stone, kankar, etc. from local authorities.

iii) If pursuant to or under any law, notification or order any royalty, cess or the hike becomes payable to the Government of India and does not at any time become payable by the contractor to the State Government/ Local authorities in respect of any material used by the contractor in the works then in such a case, it shall be lawful to the Government of India and it will have the right and be entitled to recover the amount paid in the circumstances as aforesaid from the dues of the contractor.

CLAUSE 35

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

i) All tendered rates shall be inclusive of all taxes and levies payable under respective statutes. However, pursuant to the Constitution (46th Amendment) Act. 1982, if any further tax or levy is imposed by Statute, after the last stipulated date for the receipt of tender including extensions if any and the contractor thereupon necessarily and properly pays such taxes/levies the contractor shall be reimbursed the amount so paid, provided such payments, if any, is not, in the opinion of the Chief General Manager (whose decision shall be final and binding on the contractor) attributable to delay in execution of work within the control of the contractor.

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

iii) The contractor shall, within a period of 30 days of the imposition of any such further tax or levy, pursuant to the Constitution (Forty Sixth Amendment) Act 1982, give a written

notice thereof to the Engineer-in-Charge that the same is given pursuant to this condition, together with all necessary information relating thereto.

CLAUSE 36

Imprisonment of Contractor

If the contractor is imprisoned, becomes insolvent compound with his creditors, has a receiving order made against him or carries on business under a receiver for the benefit of the creditors or any of them, or being a partnership firm becomes dissolved, or being a company or corporations goes into liquidation or commences to be wound up not being a voluntary winding up for the purpose only of amalgamation or reconstitution the department shall be at liberty.

(a) To give such liquidator, receiver, or other person in whom the contract may become vested, the option of carrying out the contract or a portion there of to be determined by BUIDCo, subject to his providing an appropriate guarantee for the performance of such contract or.

(b) To terminate the contract, forthwith by notice in writing to the contractor, the liquidator, the receiver or person in whom the contract may become vested and take further action as provided in the relevant clauses of the contract.

CLAUSE 37

Termination of Contract on death of contractor

Without prejudice to any of the rights or remedies under this contract if the contractor dies, the Divisional Officer on behalf of the Governor of Bihar shall have the option of terminating the contract without compensation to the contractor after the affidavit of his/ their legal heir/heirs that they are not going to be in this profession in future.

CLAUSE 38

If relation working in PWD then the contractor not allowed to tender

The contractor shall not be permitted to tender for works in the P.W.D. Division (responsible for award and execution of contracts) in which his near relative is posted as Accountant or as an officer in any capacity between the grades of the General Manager (Works) and Dy. Project Director (both inclusive). He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any Gazetted Officer in the P.W.D. or in BUIDCo. Any breach of this condition by the contractors of BUIDCo shall lead to blacklisting. If the contractor is registered in any other department, he shall be debarred from tendering in BUIDCo for any breach of this condition.

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

CLAUSE 39

No-Gazetted-Engineer to work as Contractor within two years of retirement

No engineer of gazetted rank of other gazetted officer employed in engineering of administrative duties in an engineering department of the Government of Bihar shall work as a contractor or employee of a contractor for a period of two years after his retirement from government service without the previous permission of State Government in writing. This contract is liable to be cancelled if either the contractor or any of his employees is found at any time to be such a person who had not obtained said permission prior to engagement in the contractor’s service, as the case may be.

CLAUSE 40

Return of material and recovery for excess material issued

i) After completion of the work and also at any intermediate stage in the event of non-reconciliation of materials issued, consumed and in balance (see Clause 10) theoretical quantity of materials issued by the BUIDCo for use in the work shall be calculated on the basis and method given hereunder.

a) Quantity of cement & bitumen shall be calculated on the basis of quantity of cement & bitumen required different items of work as shown in the Schedule of Rates mentioned in-

Schedule 'F'. In case any item is executed for which standard constants for the consumption of cement or bitumen are not available in the above mentioned schedule / statement or cannot be derived from the same shall be calculated on the basis of standard formula to be laid down by the Engineer in Charge.

b) Theoretical quantity of steel reinforcement of structural steel sections shall be taken as the quantity required as per design or as authorised by Engineer in Charge, including authorized laps, chairs etc., plus 3% wastage due to cutting into pieces, such theoretical quantity being determined and compared with the actual issues each diameter wise, section wise and category wise separately.

c) For any other material as per actual requirements.

ii) Over the theoretical quantities of materials so computed a variation shall be allowed as specified in Schedule 'F'. The difference in the net quantities of material actually issued to the contractor and the theoretical quantities including such authorised variation, if not returned by the contractor or if not fully reconciled to the satisfaction of the Engineer in Charge within fifteen days of the issue of written notice by the Engineer in Charge to this effect shall be recovered at the rates specified in Schedule 'F' without prejudice to the provision of the relevant conditions regarding return of materials governing the contract. Decision of Engineer in Charge in regard to theoretical quantities of materials, which should have been actually used as per the Annexure of the standard schedule of rates and recovery at rates specified in Schedule 'F', shall be final & binding on the contractor

For non-scheduled items, the decision of the General Manager (Works) regarding theoretical quantities of materials, which should have been actually used, shall be final and binding on the contractor.

iii) The said action under this clause is without prejudice to the right of BUIDCo to take action against the contractor under any other conditions of contract for not doing the work according to the prescribed specifications.

CLAUSE 41

Release of Security deposit

On completion of the whole of the work, half of the total amount of security shall be repaid to the contractor after six months of completion. However, the balance half of the total amount of security will be returned after completion of defect liability period and after the Engineer has certified that all defects notified by him to the contractor before the end of this period have been corrected and also after recovery of any dues.

CLUASE 42

Responsibility of Technical Staff and employees

Technical officers / staff deployed by the Contractor at any construction site will also be responsible for inferior quality / poor performance of any work and his name will be circulated to all works Sites of BUIDCo to debar from any other site, if his name is being proposed by other contractor.

CLAUSE 43

Contractor's Risks

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

CLAUSE 44

Insurance

The Contractor shall provide, in the joint names of BUIDCo 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 damage of property (except the Works, Plant, Materials and Equipment) in connection with the Contract; and

(d) personal injury or death.

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.

If the Contractor does not provide any of the policies and certificates required, BUIDCo may effect the insurance which the Contractor should have provided and recover the premiums BUIDCo 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.

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

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

CLAUSE 45

Cash Flow Estimate to be Submitted

The Contractor shall, within the time stated in special Conditions of contract after the date of the Letter of Acceptance, provide to the Engineer for his information a detailed cash flow estimate, in quarterly periods, of all payments to which the Contractor will be entitled under the Contract and the Contractor shall subsequently supply revised cash flow estimates at quarterly intervals, if required to do so by the Engineer. in charge

CLAUSE 46

Safety, Security and Protection of the Environment

The Contractor shall, throughout the execution and completion of the Works and the remedying of any defects therein:

(a) have full regard for the safety of all persons entitled to be upon the Site and keep the Site (so far as the same is under his control) and the Works (so far as the same are not completed or occupied by BUIDCo) in an orderly state appropriate to the avoidance of danger to such persons,

(b) Provide and maintain at his own cost all lights, guards, fencing, warning signs and watchmen and where necessary or required by the Engineer or by any duly constituted authority, for the protection of the Works or for the safety and convenience of the public or others, and

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

CLAUSE 47

Cost of Samples

All samples shall be supplied by the Contractor at his own cost if the supply thereof is clearly intended by or provided for in the Contract.

CLAUSE 48

Cost of Tests

The cost of making any test shall be borne by the Contractor if such test is:

(a) clearly intended by or provided for in the Contract, or

(b) particularized in the Contract (in case only of a test under load or of a test to ascertain whether the design of any finished or partially finished work is appropriate for the purposes which it was intended to fulfill) in sufficient detail to enable the Contractor to price or allow for the same in his Tender.

CLAUSE 49

Cost of Tests not Provided for

If any test required by the Engineer which is:

(a) not so intended by or provided for,

(b) (in the cases above mentioned) not so particularized, or

(c) (though so intended or provided for) required by the Engineer to be carried out at any place other than the Site or the place of manufacture, fabrication or preparation of the materials or Plant tested,

shows the materials, Plant or workmanship not to be in accordance with the provisions of the Contract to the satisfaction of the Engineer, then the cost of such test shall be borne by the Contractor, but in any other case department will bear the cost.

CLAUSE 50

Commencement of Works

The contractor shall commence the Works as soon as is reasonably possible after the receipt by him of a notice to this effect from the Engineer, which notice shall be issued within the time stated in the Appendix to Tender after the date of the Letter of Acceptance. Thereafter, the Contractor shall proceed with the Works with due expedition and without delay.

CLAUSE 51

Substational completion of parts

If any part of the Permanent Works has been substantially completed and has satisfactorily passed any Test on Completion prescribed by the Contract, the Engineer may issue a Taking-Over Certificate in respect of that part of the Permanent Works before completion of the Works and, upon the issue of such Certificate, the Contractor shall be deemed to have undertaken to complete with due expedition any outstanding work in that part of the Permanent Works during the Defects Liability Period.

CLAUSE 52

Force Majeure

Force Majeure

Neither party shall be liable to the other for any loss or damage occasioned by or arising out of acts of GOD such has Unprecedented flood, Volcanic eruption, Earthquake or other convulsion of nature and other acts such as general/ partial strikes by a section of government employees/ invasion, the act of foreign countries/ hostilities or war like operations before or after declaration of war, rebellion/ military or usurped power which prevent performance of the contract and which could not have been foreseen or avoided by a prudent person.

CLAUSE 53

Recovery

Recovery

Any amount found recoverable from the contractor shall be recovered as public demand under the Bihar Public Demand Act. without prejudice to any other mode of recovery.

SECTION 4

CONTRACT DATA
(PROFORMA OF SCHEDULES)

PROFORMA OF SCHEDULES

(Operative Schedules to be supplied separately to each intending tenderer)

SCHEDULE 'A'

Schedule of quantities

Sl. No.	Description of Item(with brief specification and reference to book of specification)	BILL OF QUANTITY				Amount
		Quantity	Unit	Rate		
				In figure	In words	
1	2	3	4	5	6	7
	Attached					

SCHEDULE 'B'

Schedule of materials to be issued to the contractor.

S. No.	Description of item	Quantity	Rates in figures & words at which the material will be charged to the contractor	Place of Issue
1	2	3	4	5
			NIL	

SCHEDULE 'C'

Tools and plants to be hired to the contractor

Sl. No.	Description	Hire charge per day	Place of Issue
1	2	3	4
		NIL	

SCHEDULE 'D'

Extra schedule for specific requirements / document for the work, if any.

SCHEDULE 'E'

Schedule of component of Cement, Steel, other Materials, Labour etc. for price escalation.

CLAUSE 10 CA **- As per SBD, GoB**

Component of Cement-
expressed as percent of total value of work. **Pc**

Component of Steel-
expressed as percent of total value of work.
Component of CI/DI Pipes and specials **Ps**

CLAUSE 10 CC **- Not Applicable**

Component of Cement-
expressed as percent of total value of work. **Pc**

Component of Steel-
expressed as percent of total value of work.
Component of CI/DI Pipes and specials **Ps**

Component of civil (except cement & steel)/
Electrical construction Materials expressed
as percent of total value of work- **Pm**

Component of Labour-
expressed as percent of total value of work. **P1**

Component of P.O.L. –
expressed as percent of total value of work. **Pf**

Component of Plant & Machinery –
expressed as percent of total value of work. **Pp**

SCHEDULE 'F'

Reference to General Condition of Contract

Name of work	**As per NIT**
Estimated cost of work	**As per NIT**
Earnest money	**As per NIT**
Performance Guarantee	**2% of 10 Crore Plus 1% of remaining amount of tendered value**
Security Deposit	**8% of tendered value (to be deducted from RA Bill)**
Defect Liability period	**3 Year from the date of completion of project.**
Rate of Interest	**Prevailing lending rate of interest floated by SBI at the time of first installation of Mobilization Advance**

GENERAL RULES AND DIRECTIONS : **Managing Director,BUIDCo.**
Maximum percentage for quantity of items of work to be executed beyond Which rates are to be determined in Accordance with Clauses 12.2 & 12.3 See below

Definitions:

2(v)	**Engineer-in-Charge**	**To be given in the letter for award of work by BUIDCo**
2(x)	**Percentage on cost of materials and labour to cover all overheads and profits.**	**10 %**
2(xi)	**Standard Schedule of Rates**	**As published & issued by BCD SOR 2020 and RCD SOR 2020**
2(xii)	**Department & Employer**	**ManagingDirector Bihar Urban Infrastructure Development Corporation Ltd. (BUIDCo) (A Govt. of Bihar Undertaking)**
9(ii)	**Standard PWD Contract Form**	**PWD 2/3 as modified & corrected upto**

Clause 1

i)	**Time allowed for submission of performance Guarantee from the date of issue of letter of acceptance, in days**	**15days**
ii)	**Maximum allowable extension beyond the period provided in i) above in days**	**0days**

Clause 2

Authority for fixing compensation under clause 2. **Chief Engineer, BUIDCo**

Clause 2A

Whether Clause 2A shall be applicable **N/A**

Clause 5

Number of days from the date of issue of notice to start. **07 days**

Milestone(s) as per table given below:

Table of Milestone(s)

Sl. No.	Description of Milestone (Physical)	Time allowed in days (from date of start)	Amount to be with-held in case of non-achievement of milestone
1.	1/8TH (of whole work)		
2.	3/8TH (of whole work)		
3	3/4TH (of whole work)		
4.	Full		

OR

Sl. No.	Financial Progress	Time allowed (from date of start)	Amount to be with-held in case of non-achievement of milestone
1.	1/8TH (of whole work)	1/4TH (of whole work)	In the event of not achieving the necessary progress as assessed from the running payments, 1% of the tendered
2.	3/8TH (of whole work)	1/2TH (of whole work)	
3.	3/4TH (of whole work)	3/4TH (of whole work)	

4.	**Full**	**Full**	**value of work will be withheld for failure of each milestone.**

Time allowed for execution of work **12 Months**

Authority to give fair and reasonable extension of time for completion of work. **MD, BUIDCo.**

Clause 7

Gross work to be done together with net payment/ adjustment of advances for material collected, if any, since the last such payment for being eligible to interim payment **Not Applicable**

Clause 10CC

Clause 10CC to be applicable in contracts with stipulated period of completion exceeding the period shown in next column **As per SBD, GoB**

Clause 11

Specifications to be followed for execution of work **Bihar PWD/ CPWD**

Clause 12

Deviation, variation Extent and pricing. **As per P.W.D. Code clause 182A, 292XII, 293XVII & 294XVI**

Clause 13

Competent Authority for deciding reduced rates. **MD, BUIDCo**

- **The following document also forms part of the contract. *Special Condition attached.***
- **The law, which applies to the contract, is The Law of Union of India.**
- **The court of jurisdiction** **Patna, Bihar**
- **The Language of contract document** **English**
- **The limit of sub-contracting** **Nil**
- **The Currency of the Contract is** **Indian Rupees**
- **Place of Arbitration** **Patna**

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SECTION 5

SPECIAL CONDITION OF CONTRACT

(Condition of Particular Application)

For the general guidance and information of the prospective tenderers a brief note on the existing water supply system for Munger Nagar Nigam is given below, HOWEVER THE TENDERERS MUST NOTE THAT BEFORE PARTICIPATING IN THE BID, THEY MUST VISIT THE SITE AND SATISFY THEMSELVES BY BECOMING FULLY CONVERGENT/ FAMILIAR WITH THE ENTIRE EXISTING SYSTEM AND ALL RELEVANT SITE CONDITIONS. THE RATES QUOTED MUST BE INCLUSIVE OF ALL TAXES AND DUTIES FOR ALL THE COMPONENTS.

Type of soil: - In general the soil is alluvial mixed with fine sand.

Project Background:

Patna City has a very long river line surrounded on three sides by River Ganga in the north, River Sone in the west, and River Punpun in the south. River Gandhak flows into River Ganga making the city a unique place having four large rivers in its vicinity. Topographically, Patna City is like a saucer having a mild slope from north to south. The broad-gauge railway line virtually divides the topographic conditions of the city. Area in the south of the railway line is almost flat and rainwater often remains accumulated in a vast pan of urban landscape for the major part of the year.

The region experiences heavy rainfall during the south-west monsoon season. During this period, when the water level reaches high flood level in the River Ganga, flood water from the river enters into the city as well as backflow occurs from the river through the River Punpun and floods the low-lying areas of the southern part of the city. Coupled with these natural disadvantages, rapid urbanization and age-old drainage system are the principal causes of continuous waterlogging and frequent flooding in many pockets and low-lying areas in the city and adjoining towns.

With the recent memory of disastrous flood situation in Patna city and adjoining areas in 2019, a new realization has come wherein we need to look into the holistic picture of the problems to avoid undue misery to the urban citizens and the associated loss to the State / national revenue and find long term solutions.

A high-level committee has been constituted to study the problems in the Storm water drainage infrastructure in Patna City and adjoining towns of Danapur, Khagaul and Phulwarisharif and the following are findings of the High Level committee:

- Water logging in Patna was mainly due to presence of old drainage system.
- Insufficient capacity of DPS.
- Rainwater not reaching the DPSs,
- DPSs motor floor levels were below Road levels due to which seven DPSs were submerged.

- Improper maintenance and operation of existing DPS.
- Clogged drains.
- Capacity of major drains were reduced due to siltation and solid waste disposal.
- Improper connectivity of drain

As part of the above recommendations, work is being undertaken and this work is pertaining to the construction of new Drainage Pumping Stations at 22 locations.

Scope of work: The scope of work includes Construction, Erection, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

(A) Kind and Scope of Work

The scope of work includes Construction, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

The Successful bidder has to build a complete and fully functioning Storm Water Drainage Pumping Stations with outfall pipeline to the designated disposal point in accordance with the Bid Documents. The scope of work shall include the following activities:

- Field survey and investigation with total station and GIS & Geo technical survey wherever required. The successful bidder shall be responsible for all subsoil exploration and other necessary site investigations required for structural design of Drainage Pumping Stations.

- Construction and Commissioning of all Civil Works required for Drainage Pumping Stations.

- Supply and Erection of Screens, Pumps and associated valves and all other Electromechanical Items required for the Drainage Pumping Stations.

- Carry out Trial Tests and Commissioning of the Pumping Station in Totality.

- Construction of outfall pipe/ channel

The design, construction and commissioning shall be executed in compliance with international best practice and all relevant Indian legislation.

Following are the proposed Pumping Stations with location reference in Patna:

Name and Location of Proposed Drainage Pumping Stations

S. No	Name of DPS	Northing	Easting
1	Big Hospital	25°35'11.38"N	85°11'43.53"E
2	Khagaul - Danapur near Hitech Hospital	25°37'14.14"N	85° 2'24.51"E
3	Bakri Bazar	25°36'37.03"N	85°10'38.99"E
4	Karori chak	25°34'10.85"N	85° 5'20.95"E
5	Dasaratha	25°34'42.96"N	85° 7'27.38"E

S. No	Name of DPS	Northing	Easting
6	Digha (Near Old Thana)	25°38'46.80"N	85° 4'52.00"E
7	Nandlal Chhapra	25°35'7.16"N	85°10'20.14"E
8	Premkunj (Kamali Chowk)	25°34'28.40"N	85°14'3.28"E
9	Rajiv Nagar	25°37'19.42"N	85° 4'57.55"E
10	Beur Betaura Pul	25°33'53.16"N	85° 5'44.23"E
11	Isopur Brama Ashtan	25°33'19.47"N	85° 3'44.28"E
12	Gurudaur Nehru Path	25°37'40.08"N	85° 4'15.00"E
13	Khanpura	25°32'27.20"N	85°14'28.00"E
14	Barmutta	25°31'51.49"N	85°13'31.33"E
15	Patna Canal DPS @ Digha	25°39'1.36"N	85° 4'49.64"E
16	Sandalpur	25°36'1.30"N	85°11'32.89"E
17	Bahadurpur TV Tower	25°35'32.27"N	85°10'11.30"E
18	Saidapur NCC	25°36'38.30"N	85°10'8.76"E
19	Rampur	25°36'41.08"N	85°10'28.15"E
20	Congress Maidan	25°36'32.43"N	85° 9'10.68"E
21	RMRI	25°35'57.47"N	85°11'47.39"E
22	RK Avenue	25°36'39.80"N	85° 9'35.18"E

Basic Design Features

Following are the tentative parameters of the pump houses:

S. No.	DPS Name	Discharge (Cumecs)	Ground level (m)	Min. water level (m)	Sump Floor level (m)	Motor Floor level(m)	Delivery Pipe Center line level (m).
1	Big Hospital	1.81	+ 49.12	+ 44.62	+ 41.77	+ 51.62	+ 52.47
2	Khagaul - Danapur Near Hitech Hospital	2.38	+ 49.50	+ 44.50	+ 41.35	+ 52.00	+ 52.90
3	Bakri Bazar	2.71	+ 49.69	+ 43.69	+ 40.44	+ 52.19	+ 53.14
4	Karori chak	2.76	+ 49.99	+ 45.49	+ 42.14	+ 52.49	+ 53.44
5	Dasaradta	3.19	+ 50.09	+ 44.59	+ 41.09	+ 52.59	+ 53.59
6	Digha (Near Old Thana)	3.45	+ 50.48	+ 43.98	+ 40.36	+ 52.98	+ 53.98
7	Nandlal Chhapra	3.87	+ 49.50	+ 43.00	+ 39.25	+ 52.00	+ 53.00

8	Premkunj (Kamali Chowk)	4.11	+ 49.99	+ 44.14	+ 40.37	+ 52.49	+ 53.54
9	Rajiv Nagar	4.24	+ 49.36	+ 43.61	+ 39.74	+ 51.86	+ 52.91
10	Beur Betaura Pul	4.7	+ 50.48	+ 43.98	+ 39.96	+ 52.98	+ 54.03
11	Isopur Brahma Ashtan	4.76	+ 50.00	+ 43.50	+ 39.48	+ 52.50	+ 53.60
12	Ghurdaur Nehru Path	6.7	+ 49.00	+ 42.50	+ 38.75	+ 53.00	+ 54.00
13	Khanpura	18.77	+ 48.00	+ 42.50	+ 37.83	+ 50.50	+ 51.70
14	Barmutta	18.87	+ 48.50	+ 43.00	+ 38.33	+ 51.00	+ 52.20
15	Patna Canal DPS @ Digha	7.17	+ 52.00	+ 48.00	+ 44.13	+ 54.00	+ 55.00
16	Sandalpur	5.6	+ 49.09	+ 45.09	+ 38.09	+ 53.96	+ 52.16
17	TV Tower	6.44	+ 49.89	+ 44.30	+ 39.20	+ 54.30	+ 52.50
18	Saidapur NCC	14	+ 49.15	Pumps are already tendered for these pumping stations and only civil structures are required. For RK Avenue Submersible pumps are proposed.			
19	Rampur	5.04	+ 49.83				
20	Congress Maidan (Kadamkaun)	2.6	+ 49.30				
21	RMRI	2.6	+ 50.48				
22	RK Avenue	2.1	+ 49.56				

(B) Build Specifications

The Operator shall be responsible for the provision of all relevant permits necessary for construction as defined in the attached bid document.

(C) Technical Documentation

The following documents shall form an integral part of the contract:

• The Agreement for the Construction of Drainage Pumping Stations

• The Bidders Technical Proposal. The Operator shall have familiarized himself with;

• The Project Implementation Plan.

SPECIAL CLAUSES PERTAINING TO TIME CONTROL QUALITY CONTROL AND COST CONTROL

(A) TIME CONTROL

Within the time stated in the Contract data the contractor shall submit to the Engineer in charge for approval a program showing the general methods, arrangements, order, and timing for all the activities in the works along with monthly cash flow forecast.
An update of the program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.

The contractor shall submit to the Engineer in charge, for approval, an updated program at intervals no longer than the period stated in the contract data. If the contractor does not submit an updated program within this period, the Engineer in charge may withhold the amount stated in the contract data from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue program has been submitted.

The Engineer's approval of the program shall not alter the contractor's event occur 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.

(B) QUALITY CONTROL

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 in charge may instruct the contractor to search for a defect and to uncover and test any work that the Engineer in charge considers may have a defect.

If the Engineer in charge 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.

The Engineer in charge 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.

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.

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

(C) COST CONTROL

The bill of quantities shall contain items for the construction, installation, testing, and commissioning work to be done by the contractor.

The bill of quantities is used to calculate the contract price.

CERTIFICATE OF UNDERTAKING

1. We shall replace, repair and adjust free of all charges to the Employer any part of the work which fails to comply with the specifications for, wear and tear expected until the completion.

2. All the work will be reliable. The material and equipment supplied will be as per the information given in schedule.

3. All the work will be of a type which has been proved in service to be suitable for the duty required by the specifications and will have been manufactured and tested in accordance with the appropriate standard specifications approved by the Engineer in charge.

4. We accept and abide by the clauses relating to Quality and guarantee of work.

5. All the testing of materials like Cement, Steel, M.S. plates etc., required during the execution of the contract will be got tested by me at my own cost from Government recognized Laboratory. The sampling and testing will be done as given in relevant I.S. Codes.

6. We will comply with all necessary rectification within total time granted for rectification without any cost to BUIDCo.

VOLUME - III

SECTION 6
TECHNICAL SPECIFICATION

TECHNICAL SPECIFICATIONS FOR CIVIL, MS PIPELINE, HYDRO-MECHANICAL AND ELECTRO-MECHANICAL WORKS

I N D E X

PART – A

CIVIL WORKS

1.0 INTRODUCTION AND SCOPE OF WORK

1.1INTENT OF TECHNICAL SPECIFICATIONS

1.1.1 The General Technical Specification (hereinafter called GTS) broadly cover the information about site conditions, transport requirements, excavation, execution of works like masonry, concrete, steel, etc., construction materials and general requirements. The GTS also covers the broad specifications and regulations for all major civil works included in the contract documents as well as the conditions for measurements and payments.

1.1.2 The items of works are based on Employer's preliminary designs as indicated in Bid Document. These specifications shall be part of the requirements for various items related to the work, which are to be provided according to the stipulations of the contract. The items of works may be modified /altered to meet the requirements of Bidder's Design and Engineering of the permanent civil works. Accordingly, the technical specifications may require additions/alterations to conform to Bidder's Design and Engineering mutually agreed to with the Employer. However, the technical specifications shall be in general as per Bureau of Indian Standards or corresponding International Standards as mutually agreed by the Employer and the Contractor during preparation of detail design and drawings and approval thereof.

1.1.3 These specifications shall be read in conjunction with the Conditions of Contract, the drawings and the preliminary Schedule of Works. While quoting the price the Contractor shall comply with all provisions contained within the bidding documents and instructions of the Engineer-in-Charge.

1.1.4 All works shall be executed according to the drawings approved by the Engineer-in-Charge for construction, in a professional and diligent manner and all supplies and works shall comply with the quality requirements defined in the relevant sections of these specifications and other bidding documents. The Contractor shall endeavour to provide all such necessary efforts in order to comply with the intent of these specifications to the satisfaction of the Engineer-in-Charge.

1.1.5 Addenda to these specifications may be issued, as required, during bidding that will form part of these specifications.

1.2SCOPE OF WORK

The scope of work includes Design, Engineering, Construction, Supply, Installation, Testing and Commissioning of 22 Storm Water Drainage Pumping Stations in Patna, Bihar.

The scope of work includes Construction Civil Works, Electro-Mechanical Works, Hydro-Mechanical works pertaining to the Pumping Stations and Final Disposal Pipeline.

1.2.1**Pumping Station:**

It is proposed to excavate the Pumping Station with a required bottom size to a required suitable bottom level as per design. The proposal consists of Inlet Chanel, Trashracks, Gates and Sump cum Pumping Station. EOT crane along with necessary support system of suitable capacity is to be erected.

1.2.2**Pressure Mains:**

It is proposed to take up suitable diameter of MS pressure mains for lifting the suitable discharge from the sump cum pumping station to outfall for a suitable length as per design.

1.2.3 The successful bidder has to submit the detailed designs to the employer for approval before executing the works.

1.3 **EXECUTION OF WORKS:**

The successful bidder, after approval of the design and drawings by the employer has to execute the works as per the specifications given in the subsequent sections of this volume.

1.4. **MEASUREMENT & PAYMENT:**

The quantum of work of different items will be measured periodically by the concerned Engineer-in – Charge or the contractor has to bill the quantities of work done periodically and produce to the Engineer-in – Charge to Asses the quantum of the work done. The payment will be made proportionate to the value of work done as per the conditions stipulated in this document.

2.0 TRANSPORTATION

2.1 The Contractor should make his own assessment about the accessibility to work site, quarry areas or otherwise and also the mode and means of transportation as would be required for execution of requisite works.

2.2 The Contractor shall be responsible to select proper routes to meet his needs and shall bear all costs of transportation including loading and unloading as deemed fit by the Contractor.

2.3 The costs, if any, for adjusting, modifying roads and bridges shall be borne by the Contractor. The Contractor shall submit for approval of the Engineer the method of transportation and routes he proposes to use.

2.4 In case any approval from the concerned authorities are required for transportation of materials through road/railway, the Contractor shall make necessary arrangements for obtaining the same, well in advance to avoid any interruption in works for want of materials, etc.

3.0 WORKING FACILITIES

3.1 GENERAL

3.1.1 Scope

The Contractor shall design, provide, erect, operate and maintain the working facilities required for the execution of the Permanent Works, within the specified time schedule, such as but not necessarily limited to:

- Camp and Facilities
- Plant and Equipment
- Electric Power Supply System
- Telephone and Communication Network
- Water Supply System
- Sewage and Waste Water System
- Fire Fighting Equipment
- Temporary Access and Construction Roads
- Testing Laboratory

Working facilities shall be subject to the Engineer-in-Charge's approval. The Contractor shall comply with all applicable laws, regulations, and ordinances relating to the construction and operation of the working facilities.

Materials for the working facilities shall be of first-class quality and if not new, in best condition. The capacity and number of equipment shall conform to the specific minimum requirements for the works they are intended for and the climatic conditions prevailing at the site. The capacity and number of equipment shall be determined taking into account of the requirement of equipment throughout the entire work.

The Contractor shall attach to his bid documents drawings, pictures and operating descriptions for his proposed working facilities and shall indicate weight, standards, capacity, manufacturing date and country of origin.

The Contractor shall, prior to dispatching any items of the Working Facilities, give written notice to the Engineer-in-Charge with clear indications about the purpose of the items, the kind, date and place of consignment (factory or the Contractor's premises). Said notice must be given in due time to allow for a possible cancellation in case the items do not comply with the requirements as stipulated. The Engineer-in-Charge will agree or disagree with the inquiry in writing within the next 15 days on arrival of the notice.

The Contractor shall provide all his equipment with sufficient spare parts, special tools for repair work and complete standby units of vital parts to guarantee a continuous operation without untimely delays. The Contractor is fully responsible for any delays due to disregard of said necessity.

Should the Engineer-in-Charge determine that the equipment furnished does not meet all requirements, the deficiencies shall be corrected by the Contractor before further use, or the deficient equipment shall be replaced with satisfactory equipment any cost incurred in the correction or replacement shall be borne by the Contractor.

All Working Facilities shall be built in the areas indicated by the Engineer-in-Charge. The Contractor shall submit prior to the start of the Works to the Engineer-in-Charge for approval, a drawing showing the exact positions of the main Working Facilities.

3.2SUBMISSIONS

The Contractor shall submit basic plans of Working Facilities together with his bid.

3.3 CAMP AND WORKING FACILITIES

3.3.1 General

The Camp and Facilities include but are not limited to

- Staff residential quarters for the Contractor's staff
- Accommodation and canteen for the Contractor's workmen
- Miscellaneous social facilities
- Offices for the Contractor
- Miscellaneous Working Facilities
  - Warehouses and sheds for the Contractor
  - Work and repair shops

All working facilities shall be equipped with lighting arrangement, telephone, water supply with drinking water, sewage system and if necessary with air conditioning. Contractor shall make his own arrangement for electricity supply as would be necessary for all sorts of works.

3.3.2Offices for the Contractor

Offices for the Officers and staff of the Contractor shall be of sufficient size and fully furnished and equipped with sanitary facilities, telephone, etc.

3.3.3Miscellaneous Working Facilities

The Contractor shall construct and maintain warehouses, storage yard, a motor tool, repair shops, workshops, vehicle sheds, garages, fuel storages and field laboratory etc. for efficient execution of the work.

a. Warehouse(s) and Sheds

Warehouse(s) for the storage of materials, mechanical and electrical units, spare parts etc. shall be well secured, ventilated (if necessary) and waterproof and shall be installed with the necessary appliances.

b. Work and Repair Shops

All work and repair shops shall be well secured, ventilated (if necessary) and waterproof. They shall be equipped with adequate equipment and tools necessary to carry out all works and repairs which are usually to be done at the Site.

3.4 PLANT AND EQUIPMENT

3.4.1 General

The Contractor shall provide all construction plants and equipment necessary for the efficient execution of the work described in the bid documents and the Specifications and details furnished by the Contractor in the construction plant and equipment schedule.

The Contractor shall also deploy additional equipment, if needed, at his own cost for timely completion of the Works.

The Contractor may collect and use sand and gravel within the construction area provided by the Employer if approved by the Engineer-in-Charge. The Contractor shall obtain aggregate through crushing of the excavated rock and/or from outside of the area at his own expenses and responsibility if he intends to do so.

Plants and equipment for the execution of all civil works include but are not limited to:

- Plant for aggregate and concrete production
- Processing plant for filter and selected surfacing material
- Open excavations
- Steel fabrications, bending and other equipment.

3.4.2 Plant for Aggregate and Concrete Production

3.4.2.1 Aggregate Crushing Plant

The number and capacity of crushing plants for aggregate shall be sufficient enough such that daily production shall at least meets the 2-3 days elements. The processing plant for aggregate for concrete shall be capable of producing the separate aggregate size groups with the proper grading stipulated in the Specifications.

Care shall be taken so that water which has been used to wash the aggregates does not cause turbidity of the river/stream water.

The Contractor shall submit the following data for approval before ordering equipment or initiating work on the Plant:

- flow diagrams
- size and capacity of each separate piece of equipment

3.4.2.2 Cement Transportation Equipment and Storage Facilities

Transportation of bulk cement shall be accomplished in adequately designed weather-tight trucks or other means which will protect the cement completely from exposure to moisture.

Storage of bulk cement at the Site or in the railway yard shall be done in weather-tight

and properly ventilated structures with adequate provisions for the prevention of absorption of moisture. Said structures shall be complete with all equipment for loading, unloading and weighing of cement. A weather - tight equipment shall be provided for conveying cement.

The cement storage structure on the Site shall be at least for 30-day capacity.

3.4.2.3 Concrete Batching and Mixing Plant

The concrete batching and mixing plant shall be a modern and dependable, automatically controlled interlocked batch-type mixing plant. Manual operation shall also be possible in the event of fault in the automatic system. The equipment shall be capable of combining the aggregate, cement, admixtures, and water into a uniform mixture within the time limit specified and of discharging this mixture without segregation. The equipment shall provide adequate facilities for the accurate measurement and control of each of the materials entering plant. The complete plant assembly, including provisions to facilitate the inspection of all operations at all times and the adequacy and dependability of each of its parts, shall be adequate to meet the requirements of the work.

The batching and mixing plant shall have means for readily wasting any material or concrete that is improperly batched, mixed or held in the mixers too long.

Auto-balance scale for weighing concrete materials and digital instruments shall be inspected, tested and calibrated in the presence of the Engineer-in-Charge after repair and maintenance of the equipment and at least once in every two (2) months or as directed by the Engineer-in-Charge.

3.4.2.4 Batching Equipment

Batching shall be done by individual weight batching equipment. Aggregate weight batching may be cumulative but by individual size. Weighing hoppers shall be arranged to permit the convenient addition or removal of material.

Delivery of materials from the batching equipment shall be within the following limits of accuracy:

Material	Percent by Weight
Cement	2
Water	1
Aggregate smaller than 5 mm size	2
Aggregate larger than 5 mm size	3
Admixture	1

Suitable facilities shall be provided for readily obtaining representative samples of aggregate from each of the batchers for test purposes.

3.4.2.5 Mixing equipment

The mixing plant shall consist of batch type tilting mixers or pan type forced paddle mixer and a discharge hopper arranged with suitable devices for obtaining representative samples and delivering to ground level of concrete for slump, unit weight, and uniformity tests. The operator platform shall be conveniently located so

that the operator can visually observe the mixing action in at least one mixer and the discharge from all mixers. A platform for access from the control room shall be provided to permit visual inspection of the concrete in the mixers while mixing. All necessary platforms, tools, equipment shall be furnished by the Contractor.

On each mixer a consistency indicator and an acceptable device to lock the discharge mechanism until the required mixing time has elapsed shall be provided.

3.4.2.6. Digital Recorder

An accurate recorder of digital type shall be provided to make continuous visible combined record on a single chart of the separate measurement of each concrete ingredient, including all mixing water, air-entraining admixture, water-reducing and set-retarding admixture, and also mixing time of each batch after all materials are in the mixer, date and time of each batch, and the type of mix proportion.

The visible portion of the chart shall cover a period of not less than 30 minutes. All digital recorder charts shall be locked and the charts shall be submitted to the Engineer-in-Charge.

3.4.2.7 Communications

An effective telephone or two-way communication system for the exclusive use of the batch plant inspector, placement inspector and the laboratory shall be maintained. Telephones shall be provided with a suitable bell, buzzer, or light to attract attention under working conditions.

3.5 ELECTRICAL POWER SUPPLY SYSTEM

The contractor shall make his own arrangement at his own cost for power supply for construction and other uses. The Contractor shall furnish, install and maintain the electrical distribution system of required capacities to the required areas for his work.

For camp area, the Contractor shall arrange himself for a connection with the closer existing power-line.

As an alternative measure, the Contractor shall install generators of required capacity and related facilities at his own expenses in case of an excessive energy demand and/or for supply of power at the instance of power failure at the power network.

3.6 TELEPHONES & COMMUNICATION NETWORK

The temporary tele-communication system shall be established at site and the Contractor shall make necessary arrangement for the same.

The Contractor will be responsible for furnishing, installing and maintaining, the telephone and communication network to individual sites/offices and other areas like quarries etc., as needed.

The contractor shall be equipped with at least one mobile connection at site office. All the charges for telephone and communication network shall be borne by the contractor.

3.7 WATER SUPPLY SYSTEM

The Contractor shall make all necessary arrangements for the adequate supply of raw water for construction use and potable water for human consumption at the various work areas as well as at the camps. Regulating, transporting, treating and distributing the water shall be included in it.

For construction and other uses, sufficient storage of water shall be secured especially during dry seasons. The Contractor shall be fully responsible for the arrangement of necessary facilities for water supply.

Only adequately treated water which complies with the current sanitary standards will be accepted for human consumption. Installation of non potable water supply systems in the camp areas will not be permitted. Storage tanks with a reserve capacity equivalent to two (2) days of normal usage will be required for the drinking water system.

The Contractor shall take drinking water samples from time to time if so requested by the Engineer-in-Charge. The samples shall be sent for chemical and bacteriological analyses to approved laboratories at his expense and the results of the analysis shall be obtained within 7 days of the sampling.

If the sampling and testing are not properly performed, the Employer may perform the same directly and charge the Contractor for the corresponding expenses.

3.8SEWAGE AND WASTE WATER SYSTEM

The Contractor shall design, construct, equip, operate and maintain all the installation necessary to properly collect, treat and dispose of sewage from his camps and other construction facilities.

The Contractor shall not, under any circumstances, discharge sewage or contaminated water into natural streams or any open areas. The pondage system for treatment and disposal of sewage shall not be used.

Treatment and disposal of sewage shall be performed in accordance with the current related standards and laws in force in India and always subject to the Engineer-in-Charge 's approval.

The drainage systems shall be designed taking into account the rainfall rate in the area and the disposal of rainwater shall be accomplished in such a way that no stagnation of water or any erosion problem is caused which may alter the stability of the soil.

3.9 FIRE FIGHTING EQUIPMENT

The Contractor shall provide complete fire fighting equipment necessary to ensure the safety of the Work.

The Contractor shall supply and maintain an abundant length of fire hoses, fire buckets, sand buckets, approved fire extinguishers and alarm systems installed over the complete work and camp sites.

The Contractor shall have on the Site at all times a trained fire fighting and first-aid crew with the necessary mobilization means.

3.10 TEMPORARY ACCESS AND CONSTRUCTION ROADS

3.10.1 General

The Contractor shall design, construct and maintain the construction roads and related works that may be necessary, from the existing roads and tracks to the various work areas, and other areas such as camps, stores, explosive magazines, plants, disposal areas and any other areas related to the work at his own cost.

Additionally, the Contractor shall improve where necessary and maintain all the existing roads and tracks in and adjacent to the project area to the satisfaction of the Engineer-in-Charge for guaranteeing normal traffic for any kind of vehicle.

The Contractor shall be responsible for the safety of the traffic during the construction. The training for safe driving together with providing number of traffic signs are the responsibility of the Contractor. Additionally, he will be responsible for protecting against damage any part of the work and the property of others in relation to the performance of this works.

The construction roads as well as existing roads will be utilized by the Employer, and the Contractor will not be entitled for any payment for such use.

3.11 FIELD LABORATORY

The Contractor shall establish a well equipped field laboratory for testing of materials of construction and other as required at his own cost and responsibility. This laboratory shall be of the size with equipments and the with all testing facilities as per Indian or other equivalent Standards. Prior to setting up of the laboratory, Contractor should submit detail plan with exhaustive equipment-list, and list of professionals and other personnel identified for laboratory work, to the Engineer-in-Charge for approval.

The laboratory shall be established as early as possible. The Contractor shall collect the samples as specified or as directed by the Engineer-in-Charge, carryout the relevant test under the guidance of Engineer or Engineer-in-Charge’s representative, prepare the complete report and submit them to the Engineer-in-Charge.

All tests shall be made according to approved standards and therefore, the equipment shall comply with the same standard. All relevant standards shall be made available in the laboratory. For any material/work in particular where the Contractor’s laboratory has no facility, tests shall be got done in an outside standard laboratory with the approval of Engineer-in-Charge at Contractor’s cost.

The laboratory shall be provided with light, ventilation, water, telephone, air-conditioner, cold and hot water supply, tank for curing, heating, toilet, etc., and be spacious enough in order to store the test samples. The details and location of the laboratory are subject to the Engineer-in-Charge 's approval.

4 GEOTECHNICAL AND CONSTRUCTION MATERIAL INVESTIGATION

4.1 GENERAL

The Contractor shall conduct all necessary geotechnical and construction material investigation as specified in the various sections of the Technical Specifications of different works with the prior intimation to the Engineer.

4.2 MEASUREMENT AND PAYMENT

No work related to any geotechnical and construction material investigations will be measured for the purpose of payment. There will be no separate payment for the investigations and related auxiliary services, as the cost thereof is deemed to be included in quoted price

5.0MATERIALS FOR CONSTRUCTION

5.1SCOPE OF WORK

(i) The specifications described herein under relate to the work which includes all labour, materials, equipment, transportation and services required to arrange materials for construction of various works under this Contract.

(ii) Samples for testing of materials for the concrete shall be supplied by the Contractor to the Engineer-in-Charge at the Trial Mix Stage as set out in Section on "**Concrete Works**".

(iii) The specifications of some of the major construction materials are given here under. The specifications and other details for masonry stone is not included here, but given in details in the Section on "**Masonry**".

5.2SUBMITTALS

(i) The Contractor shall specify in his bid and subsequently also, if asked by the Engineer-in-Charge, the source(s) from which the cement, steel etc. will be obtained. In case the specified source(s) is not acceptable to the Engineer-in-Charge, the Contractor shall be required to substitute the source by an acceptable source. Additional suppliers and change of suppliers shall be subject to the approval of the Engineer-in-Charge.

(ii) At least 30 days prior to procuring or dispatch of the materials to site, the Contractor shall submit the following to the Engineer-in-Charge:

(a) **Certified quality test reports** from manufacturers in respect of cement, steel and other materials. This will also be necessary whenever the source is changed or when the sub-standard materials are received on the site.

(b) If the materials are to be arranged from several sources, the estimated quantity to be procured from each source and the proposed schedule of supply.

(iii) The layout of the stockpiles and the method of drawing aggregates from them shall be submitted to the Engineer-in-Charge at least 30 days prior to the commencement of stockpiling of aggregates.

(iv) The details relating to the source, method of delivery and storage of water to be used during construction shall be submitted by the Contractor to the Engineer-in-Charge for approval atleast 30 days prior to the commencement of the works.

(v) The Engineer-in-Charge reserves the right to ask for any additional information deemed necessary to be included in the submitted documents.

5.3STANDARDS

(i) The specifications, production, sampling, testing and storage of constructional materials shall conform to the following latest Indian Standards or where not covered by these Standards, to the equivalent International Standards :

(a) Aggregates and Water

IS:456-2000 (Code of Practice for Plain & Reinforced Concrete)
IS:383-2000 (Specification for Coarse and Fine Aggregates for Natural Surface for Concrete)
IS:2116-1992 (Sand for masonry mortar)
IS:2386 (Part-IV)-1963 (Reaffirmed 1990) (Method of Tests for Aggregate for Concrete)
IS:516-1959 (Reaffirmed 1991) (Method of Tests for Strength of Concrete)

(b) Cement

IS:269-1989 (Specification for 33 Grade Ordinary Portland Cement)
IS:1489-1991 (Specification for Portland Pozzolona Cement)
IS:8112-1989 (Specification for 43 Grade Ordinary Portland Cement)
IS:12269-1987 (Specification for 53 Grade Ordinary Portland Cement)
IS:12330-1988 (Specification for Sulphate Resisting Portland Cement)
IS:455-1989 (Specification for Portland Slag Cement)

(c) Steel for Reinforcement

IS:432 (Part-I)-1982 (Reaffirmed 1995) (Mild Steel and Medium Tensile Steel Bar)
IS:1786-1985 (Reaffirmed 1990) (Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement)

(d) Structural Steel

IS:2062-1992 (steel for General structural purposes)
IS:808-1989 (Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections)
IS:8500-1991 (Structural Steel Medium and High Strength Qualities)
IS:800-1984 (Reaffirmed 1991) (Code of Practice for General Construction in Steel)

(e) Steel for fabrication of Pipes

IS:6286-1971 (Reaffirmed 1988) (Seamless and Welded Steel Pipes for Sub-zero Temperature Service)
IS:3589-1991 (Electrically Welded Steel Pipes for Water, Gas and Sewage)
IS:1536-1989 (Reaffirmed 1993) (Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage)
IS:6631-1972 (Reaffirmed 1988) (Steel Pipes for Hydraulic Purposes)

(f)Welding Electrodes

IS:814-1991 (Covered Electrodes for Metal Arc Welding of Structural Steels)
IS:816-1969 (Reaffirmed 1992) (Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel)

(ii) In case of conflict between the above Standards and the Specifications given herein, the Specifications shall take precedence.

5.4 BRICKS

5.4.1General

Bricks shall be hand moulded or machine moulded. They shall be free from nodules of free time, visible cracks, flaws warpage and organic matter, have a frog 100mm in length 400mm in width and 10mm to 20mm deep on one side of its flat sides. Each brick shall be marked in the frog with the manufacturer's identification mark. The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck. Bricks shall have nominal size of: 200mm x 100mm x 100mm; and shall be of class designation 10 with average compressive strength of 10N/mm^2.

5.4.2Sampling and Tests

Sample bricks shall be subject to the following tests:

(i) Dimension tolerance
(ii) Water absorption.
(iii) Efflorescence.
(iv) Compressive strength

5.4.2.1Sampling

For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken at random. The sample thus taken shall be stored in a dry place until tests are made. Sampling shall be done as per CPWD norms.

5.5STONES FOR MASONRY/AGGREGATES

5.5.1General

(i) All stones used for masonry works and concrete aggregates shall be of sound, hard, durable and of tough quality approved by the Engineer-in-Charge.

(ii) The stones shall be fine or medium grained, hard, bright in colour, breaking with a clean fracture and as such make a ringing sound when struck with a hammer.

(iii)It shall be free from decay, vesicles, holes, flaws, cracks and other defects and must have, as far as possible, uniform colour and texture. Porous stone absorbing water more than 1 (one) percent of its dry weight after 24 hours immersion shall be

rejected. No stones shattered or cracked by blasting operations or having any skin or earthy cover shall be used.

(iv) In case the stone is not considered to be free from dust or dirt etc. by the Engineer-in-Charge, the Contractor shall get the stone screened, washed and/or treated as directed by the Engineer-in-Charge.

(vi) Stone for masonry shall be roughly cubical, but not be conical in shape and stones weighing between 40 Kg to 75 Kg shall not be less than 15 cm and shall not be less than 25 cm if weighed between 75 Kg to 150 Kg in any direction. Spalls between 10 cm to 20 cm size shall also be used to wedge into the thick mortar spaces. No individual stone for use in masonry shall weigh less than 40 Kg and more than 150 Kg. Generally, the stones shall have more bedding area in the natural bedding plan. The percentage of water absorption, according to tests conforming to IS-1124-1990 shall not exceed 1% to 3% of its own dry weight, after 24 hours submersion in water. Stones for masonry shall not contain crytocrystalline silica or chertmica or any other deleterious material like iron-oxide, oganic impurities, etc. If considered necessary, the stone shall be examined petrographically in accordance with IS-1123-190.

(vii) Samples of stones that the Contractor intends to use shall be submitted for the approval of the Engineer-in-Charge not later than 45 days prior to the date of use.

5.5.2 Tests for Stones

The crushing strength in unconfined compression test shall not be less then 150 kg/cm^2 when tested on any plane. Samples of stone from quarries shall be tested for compressive strength in accordance with **IS:1121 (Part-I)- 1993**. The compressive strength testing shall be conducted with the load parallel to the bedding plane and also perpendicular to the bedding plane. The stone samples shall also be tested for water absorption **(IS : 1124-1990)** and also for soundness to ensure suitability of stones for masonry.

5.6AGGREGATES

5.6.1General

(i) Use of aggregates (coarse and fine) containing excessive amount of zeolites, secondary minerals and such other components which cause alkali reactivity of the aggregates and consequent reduction in durability of the concrete is prohibited. The Engineer-in-Charge may, however, allow the use of such material either in part or in full keeping in view the extent of reactivity, the location, the nature of exposure and the structure. If the Engineer-in-Charge considers necessary, he may carry out mineralogical tests to ascertain the lack of harmful minerals in the stones.

(ii) The Contractor shall make his own arrangements for aggregate crushing plants etc. for crushing of aggregates from stones extracted from approved quarries or other works.

(iii) The quality of all aggregates used in the works, as also processing such as washing, classifying, screening, re-screening, crushing and blending necessary to meet the required specifications shall be subject to the approval of the Engineer-in-Charge.

(iv) The aggregates shall be supplied only from the sources/quarries approved by the Engineer-in-Charge. The Contractor shall supply necessary quantities of aggregates to carry out the desired tests by the Engineer-in-Charge.

(v) The aggregates shall be sampled and tested by the Engineer-in-Charge in accordance with the Indian Standards referred above.

(vi) The tests shall be made on samples that are representative of the grading that will be used in concrete and the aggregates shall be processed by the equipment proposed for the works.

(vii) The Contractor shall at all times have access to and associate with sampling and testing of aggregates and shall be entitled to discuss with the Engineer-in-Charge, the results and proposals for grading of aggregates.

(viii) Stored Fine sand shall be stacked and maintained in such a manner as to avoid the inclusion of any foreign materials in the concrete, and such that no equipment will be operated on the storage piles. The storage piles shall be constructed so as to prevent contamination. The Contractor shall remove the excess moisture in the fine sand by adequate means.

(ix) Coarse aggregate storage piles shall be built and maintained in such a manner as to avoid the inclusion of any foreign material in the concrete and to prevent segregation and excessive breakage. No equipment shall be operated on storage piles. Rock ladders of satisfactory design shall be used with conveyor systems for stockpiling aggregate larger than 40 mm in size.

(x) Sand and aggregate storage piles shall be located close to the mixing plant and shall always contain at least a **reserve for one month**

5.6.2 Coarse Aggregates

(i) The term coarse aggregates applies to pieces of natural or crushed rock ranging in size from 4.75 mm to 150 mm.

(ii) The aggregates shall be composed of clean, hard, strong, durable pieces of stone, angular or rounded in shape obtained naturally or by crushing from suitable stones approved by the Engineer-in-Charge. Coarse aggregates shall not contain more than 15% elongated or flat particles. An elongated particle is defined as a particle having a maximum length of more than 5 times its maximum width. A flat particle is defined as a particle in which its maximum width or length is more than 5 times its maximum thickness.

(iii) Coarse aggregates delivered to the batching plant shall have a uniform and stable moisture content.

(iv) The coarse aggregates shall be free from objectionable materials such as wood or other deleterious substances, the percentage of which in any size of coarse aggregate shall conform to the relevant standards except that the coarse aggregate shall contain not more than 0.30 percent by weight of deleterious (reactive) iron sulphides. The sum of the percentage of all deleterious substances in any size shall not exceed 3

percentage by weight. Coarse aggregates having a specific gravity (saturated surface-dry basis) less than 2.60 shall be rejected.

(v) The aggregates shall be resistant to deleterious, chemical or physical changes such as cracking, swelling, softening, leaching or chemical alterations after its incorporation in concrete.

(vi) For concrete exposed to the flowing water at high velocities, the coarse aggregates having high abrasion resistance shall be used.

(vii) When subject to soundness test with a solution of Sodium Sulphate coarse aggregates shall not suffer more than 12 percent loss of weight after five cycles.

(viii) The aggregates shall be crushed in approved type of stone crushers and different sizes of the coarse aggregate shall be separated into nominal sizes by screening over vibrating screens as under :

Designation of Size Nominal size range

20 mm aggregate 4.75 mm to 20 mm
40 mm aggregate 20 mm to 40 mm
80 mm aggregate 40 mm to 80 mm
150 mm aggregate 80 mm to 150 mm

(ix) The grain-size distribution of the coarse aggregate for the various maximum sizes of aggregates shall be as set out in the relevant standards.

(x) These may be altered by the Engineer-in-Charge from time to time, if necessary, on the basis of actual tests carried out regularly in the laboratory so as to get the best possible coarse aggregate grading.

(xi) The percentage of weight of all the significant under-sizes shall be less than 5 percent when tested on the designated test screens having opening 5/6 times the normal minimum size of the material. No over size (i.e. material that would be retained on the designated test screens having opening 6/7 times the normal sizes of the material) shall be permitted.

5.5.3Fine Aggregates (Sand)

(i) General

(a) Sand or fine aggregates shall be used for mortar in stone masonry and as fine aggregates in concrete work. It shall be either natural river sand or manufactured sand crushed from rock/stones or mixture of both in specified proportions. The sand shall be composed of hard, clean and gritty pieces of stone and of a quality approved by the Engineer-in-Charge. It shall be free from injurious amount of clay, soft and flaky particles, vegetable or organic matter, loam, mica and other deleterious substances and shall not contain any salts.

(b) The fine aggregates shall conform to the requirements of IS:383-1970 (Reaffirmed 1990). Varying amount of moisture in fine aggregates contributes to lack of uniformity in concrete consistency. The fine aggregates shall therefore have

uniform and stable moisture contents. Dry sand shall be preferred. Hence sand stockpiles shall be protected from rainfall.

(c) The percentage of deleterious substances in the fine aggregates shall conform to relevant standards except that the fine aggregates shall contain not more than 0.10 percent by weight of deleterious (reactive) ferrous sulphides. The total percentage of deleterious substances must not exceed 5 percent of the weight.

(d) Fine aggregate having a specific gravity of less than 2.60 are liable to be rejected. Fine aggregates when subjected to a soundness test with a solution of sodium sulphate, after 5 cycles of tests, shall not suffer a loss of weight in excess of 10 percent.

(e) The sand shall be well graded and, when tested by standard sieves, shall conform to the prescribed limits of gradation. The best gradation shall be determined after experiments and tests and the Contractor shall follow the same on approval of the Engineer-in-charge.

(f) The sand, as delivered to the batching plant shall have a fineness modulus of 2.6 to 3. The grading of fine aggregates shall be so controlled that the fineness moduli of at least 9 out of 10 samples of fine aggregates delivered to the batching plant shall not vary more than 0.20 from the average of 10 samples tested. All classifying, batching or other operations on the fine aggregates shall be done by the Contractor.

(ii) Natural Sand

(a) Natural sand shall be obtained from an approved source. No sand affected by salty water shall be used. The sand shall be screened and thoroughly washed, preferably in flowing water so as to remove all earthy impurities and very small fines unless otherwise permitted by the Engineer-in-Charge.

(b) Natural sand shall be free from softer grains and all sources of sand showing appreciable percentage of these impurities shall be rejected.

(c) The presence of mica in the fine aggregate has been found to reduce considerably the compressive strength of concrete. It is advisable, therefore, to investigate the mica content of the fine aggregates and make suitable allowances for possible reduction in strength of concrete or mortar. The decision of the Engineer-in-Charge whether to use such sand and if so, what allowances to be made, shall be final and binding on the Contractor.

(d) The contents of the organic matter shall conform to relevant standards.
(a)

5.6.4. Storage of Aggregates

(i) The Contractor shall, at all times, maintain storage of all grades of aggregates for atleast one month requirement.

(ii) Adequate drainage of stockpiles shall be provided.

(iii) The stockpiling of the processed aggregate and drawl therefrom shall be such as to ensure that the variation in the free moisture in the aggregate, during any one shift of working, does not exceed 1 percent.

(iv) The coarse aggregate shall, as far as possible, be stored in shade or covered storage and arrangement made for sprinkling of water to ensure wetting of the aggregates.

(v) Care shall be taken in screening and stocking of the coarse aggregates so as to avoid intermixture of different gouge materials and inclusion of any foreign materials.

(vi) The stockpile shall be built up in horizontal or gently sloping layers.

(vii) Trucks and bulldozers shall be kept off the piles to prevent breakage and impairing the cleanliness of aggregate.

(viii) A hard base shall be provided to prevent contamination from underlying materials in storage areas in continuous use.

(ix) Overlap of different sizes of materials shall be prevented with suitable walls or by ample distance between storage piles.

(x) Arrangements shall be made to store natural and manufactured sand in a way that shall protect it from being contaminated with dust, organic matter or other deleterious substances.

5.7WATER

(i) A reliable water supply for construction purposes shall be installed and maintained by the Contractor.

(ii) Adequate water storage facilities shall be provided by the Contractor at the batching and mixing plant and other work sites so that various operations of works do not suffer due to temporary breakdown in the main supply system.

(iii) The Contractor shall supply water samples from the intended sources to the Engineer-in-Charge for testing and approval.

(iv) The Engineer-in-Charge shall establish the suitability of water to be used for construction purposes.

(v) Water for washing of aggregates, mixing mortar, concrete or grout and/or other construction activities shall be clean and free from earth, vegetable or organic matter, injurious amount of oils, acids, sugar, salt and alkaline substances in solution or in suspension and shall conform to relevant standards. The maximum allowable contents of sulphates (SO_4) shall be 250 parts per million (ppm) and those of chlorides (Cl) shall be 2000 mg per liter for plain concrete / mortar works and 1000 mg per liter for reinforced concrete works. Turbidity shall be within 2000 ppm (or 0.2 percent by weight) and preferably as low as possible.

(vi) Water used for curing shall be clean and free from contamination and from excess amounts of acids or alkalis or other matter combining chemically with and thus disfiguring the concrete / masonry surface. Water shall not contain organic matter causing stink.

(vii) Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90 percent of the average of strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements set out in Section on Concrete Works.

(viii) The Contractor shall bring to the notice of the Engineer-in-charge, of the occurrence of hot water found in existence during excavation. He shall supply samples of such water to the Engineer-in-Charge for testing. Suitable measures shall be taken in case such testing reveals deleterious effect on concrete.

5.8 CEMENT

5.8.1 General

(i) The Contractor shall procure the cement of the specified quality from the cement sources/plants approved by Employer/Employer. For this purpose Employer/Employer will approve atleast two sources/plants out of those intimated by the Contractor so that one is a standby for taking care of any eventualities.

(ii) Cement to be used for various works shall be of different types such as Ordinary Portland Cement or Portland Pozzolana Cement or Portland Slag Cement as approved by the Engineer-in-Charge and shall conform to the relevant Standards at the time of its use.

(iii) The Contractor shall deliver with each supply of 1000 tonnes of cement a certificate from the manufactures/suppliers by which the cement is guaranteed to comply with the requirement of the specifications. **The Employer/Employer shall have the right to check or test the cement at any stage of its manufacture or delivery and the Employer/Employer's test reports shall supersede the test report given in the manufacturer's certificate.**

(iv) Aggregate which has alkaline reactive tendency shall be avoided for use in concrete. In case, such aggregate has to be used, prior approval of the Engineer-in-Charge shall be obtained. In that case, the cement with alkali contents (i.e. Na_2O and K_2O expressed in equivalent weight of Na_2O) not exceeding 0.6 percent by weight of cement shall be used.

(v) The cement will be sampled and tested by the Engineer-in-Charge for strength and physical properties and chemical analysis will be carried out as set out in relevant standards.

(vi) The cement samples for testing at the source/plant shall be obtained by the Contractor as the bins are being filled. Tests for false set shall be made on samples taken at the latest time prior to shipment.

(vii) Ordinary port land cement conforming to latest revision of IS shall be procured from the reputed manufacturers only and will be accompanied by test certificate of manufacturers. Quality shall be checked regularly and Employer reserve the right to reject/approve cement quality after getting the same tested in approved Government Laboratories.

5.8.2 Transportation

(i) Cement shall be delivered on site in bulk/bags in bulk containers/trucks approved by the Engineer-in-Charge.

(ii) All bulk containers/carriers shall be clean and dry prior to filling/loading with cement and equipped with weather proof closures on all openings

5.8.3 Storage

(i) Sufficient storage facilities shall be provided at the batching plant to enable each new shipment of cement to be stored separately from the cement stored from earlier shipments.

(ii) Cement shall be stored above ground, adequately protected against rain, sun and moisture. Bulk storage bins and silos shall be emptied completely and cleaned of all cement accumulation **after every 3 months**.

(iii) Arrangements shall be made such that stock of approved cement are adequate to meet the programme of work at all times. The programme shall allow time for testing and approval of each shipment before such cement is incorporated in the works.

(iv) Cement shall be used in the order in which it is received on site. Cement of different brands, if received on site, shall not be combined in the same mix and structure. Such cement shall be used in different structures as approved by the Engineer-in-Charge.

(v) Handling and storage facilities shall be such that no cement is stored before use for **more than 120 days.** Should any cement be unavoidably kept in storage longer than 120 days, it shall be tested and if found defective, shall condemned for use on the project.

5.9 STEEL FOR REINFORCEMENT

5.9.1 General

(i) The Contractor shall procure the steel reinforcement of the specified quality from **the sources/plants approved by the Employer/Employer**. Sources of steel shall preferably be SAIL and TISCO.

(ii) Steel reinforcement shall conform to relevant Indian Standards or equivalent.

(iii) Steel shall be free from loose mill scale, rust, oil, grease, dirt, paint or other deleterious matter, when examined immediately before concrete is being placed.

(iv) Wire for tying reinforcement steel shall be black annealed iron wire or acceptable equivalent with a suitable diameter and shall have an ultimate strength of 5.68 tonne/sq.cm. and yield strength of not less than 8.8 tonne/sq.cm.

5.9.2 Transportation and Storage

(i) Transportation shall be undertaken in such a manner that no damage is done to the steel.

(ii) Reinforcement steel shall be stored off the ground in separate groups according to size and length. Reinforcement steel, which has been cut and bent according to the schedules approved by the Engineer-in-Charge, shall be marked with bar number, as shown in the schedule, by using same form of weather proof tag or by placing marked bins, and shall be stored in such a manner as to be readily accessible when required and to facilitate inspection.

5.10 STRUCTURAL STEEL

5.10.1 General

(i) The Contractor shall procure structural steel of the specified quality from **the sources/plants approved by the Employer/Employer**. Sources of steel shall be limited to SAIL and TISCO.

(ii) All structural steel shall be of new/unused stock, clean and straight, free from rust or scale and without any sharp kinks, bends or other objectionable defects.

(iii) All structural steel including steel plates, shall conform to relevant standards.

(iv) The material used in splices shall conform to the specifications of the material being spliced.

5.10.2 Transportation and Storage

Structural steel shall be transported, handled and stored in such a manner that no damage is done to the material or the structure.

6.0 EXCAVATION WORKS

6.1 SCOPE OF WORK

(i) The specifications described hereunder, relate to the work of excavation and shall include all labour, tools, construction plant and services, necessary to carry out the excavation of different materials, transportation and stockpiling / disposal of all excavated materials into stockpiles / dumping areas as approved by the Engineer-in-Charge.

(ii) Excavation shall be made to the lines, grades and dimensions shown on the drawings approved for construction or as otherwise agreed with the Engineer-in-Charge.

(iii) The Contractor shall maintain the excavated slopes, drainage and trenches and prepare foundations as shown on the drawings or as agreed with the Engineer-in-Charge.

(iv) The area of open excavation shall, where, in the opinion of the Engineer-in-Charge clearing is necessary, be cleared of all trees, bushes, rubbish and other objectionable matter and the materials, so removed, shall be disposed off suitably or as directed by the Engineer-in-Charge.

(v) When additional excavation outside the lines and grades shown on the drawings is required by the Contractor for his own convenience, such additional excavation shall be required to be backfilled with acceptable material and compacted by the Contractor in a manner satisfactory to the Engineer-in-Charge. The Contractor shall submit his plans for such proposed work in writing for Engineer-in-Charge's acceptance prior to the commencement of the work.

(vi) The removal of mud and slush resulting from heavy rains or flooding of the sites, when necessary to ensure the safe and effective performance of the work, shall be performed by the Contractor.

(vii) At all times during construction, the Contractor shall adopt excavation procedures such that at no time shall the stability of any slope be impaired.

(viii) The approval given by the Engineer-in-Charge to the Contractor's methods and equipment shall not relieve the Contractor of his full responsibility for a proper and safe execution of excavations, or of liability for injuries to, or death of person(s), or any obligations under this Contract.

(ix) The Contractor shall comply with all safety procedures and requirements as stipulated in this document.

6.2SUBMITTALS

(i) At least **30 days prior** to the commencement of excavation, the Contractor shall submit his programme of excavation with details of his excavating methods and sequences for all open excavation works including the equipment.

(ii) At least **30 days prior** to dumping or stockpiling of any material, the Contractor shall submit the layout of the spoil and stockpile areas, which shall be within the identified areas. All pertinent data of working methods and provisions for the security, stability and temporary and permanent drainage of the areas shall be included along with details of volumes, material types, heights and grades provided.

(iii) To enable the Engineer-in-Charge to verify all necessary setting out and elevations carried out by the Contractor, the later shall notify the Engineer-in-Charge in writing, giving **at least 7 days notice** of his intentions to start excavation.

(iv) The Engineer-in-Charge reserves the right to ask for any additional information deemed necessary to be included in the submitted documents.

6.3SETTING OUT

(i) The Contractor shall establish, at suitable points, to the satisfaction of the Engineer-in-Charge, permanent reference marks on the centerlines, as may be necessary and directed. The permanent marks shall be inscribed on bronze pegs, set in concrete blocks where they will be free from any likelihood of the disturbance. Suitable number of benchmarks with corresponding co-ordinates shall be established with

reference to SOI benchmark and grid within the project area. The reference drawing indicating all benchmarks vis-à-vis project components shall be prepared and submitted to the Engineer-in-Charge for approval.

(ii) As the work progresses, centre line marks shall be made on pegs, inserted at the convenient intervals to the satisfaction of the Engineer-in-Charge, for checking alignment, grades, levels etc. The Contractor shall at all times, remain responsible for the sufficiency and accuracy of all such benchmarks and reference points.

6.4 ACCURACY OF ALIGNMENT, GRADES AND LEVELS ETC.

(i) Bench marks and fixed reference points with the value of the levels and the coordinates, will be fixed by the Engineer-in-Charge in the work areas. The plans showing the position, co-ordinates and the levels of the salient points as available will be supplied to the Contractor. The Contractor shall fix his permanent points and benchmarks in relation to these.

(ii) The Contractor shall take all precautions to ensure that the points fixed by the Engineer-in-Charge are not disturbed by his work and shall make good the damage, if any.

(iii) The Contractor shall provide all facilities like labour, instruments, etc. and all co-operation to the Engineer-in-Charge to check the alignments, grades, levels etc. whenever and every time they are asked for.

(iv) Any discrepancy or error detected during the course of excavations and / or at the end of work shall be set right by the Contractor, in the manner satisfactory to the Engineer-in-Charge.

6.5 Earth Work Excavation

All excavation operations manually or by mechanical means shall include excavation and 'getting out' the excavated materials. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead. During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

In firm soils, the sides of the trenches shall be kept vertical up to a depth of 2 meters from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2.0 m from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 meter.

The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge.

In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for leveling/ bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed.

In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on the account shall be done by the contractor at his own cost.

The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour /mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor will any extra payment be made on this account.

The Contractor shall carry out all earthworks in such a manner as to prevent erosion or slips, shall limit working faces to safe slopes and height, and shall ensure that all surfaces have at all times sufficient gradients to enable them to shed water without causing erosion. He shall also take all other relevant precautions and as noted on the drawings.

At the end of each day, all surfaces shall be left with no area that can retain water. If necessary, the Contractor shall provide and maintain temporary and approved surface or subsurface drainage system to ensure minimum delay in working progress due to wet weather. Alternatively, adequate means, such as covering all surfaces with polythene, shall be provided and maintained.

The Contractor shall provide and maintain all necessary temporary access roads and shall divert and reinstate permanent drainage system. All temporary roads shall be provided with drainage ditches over full length.

6.5.1 Existing Services

The Contractor shall notify the Engineer. of any mains, pipes or conduits met with during the excavation and where any excavation is carried out adjacent to or under any existing cable, and the like the Contractor shall prevent damage by subsidence, as the Engineer. may direct, whether such work is shown on the drawings or not.

In the event that damage is done to the public services due the Contractor’s work or otherwise, all expenditure for such necessary repairs, etc. shall be borne by the Contractor. Should these repairs be carried out by the relevant Authorities, the

Contractor shall reimburse the Authorities for the cost of carrying out the repairs, failing which the M B P T reserves the right to pay the Authorities directly and deduct same from any monies due or becoming due to the Contractor.

6.6 Planking and Strutting:

When the depth of trench in soft/loose soil exceeds 2 meters, stepping, sloping and/ or planking and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken shall be determined by the Engineer-in-Charge according to the nature of soil.

Planking and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of planking and strutting shall be determined by the Engineer-in-Charge. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches from collapse. Engineer-in-Charge should take guidance from IS: 3764 for designing the shoring and strutting arrangements and specifying the profile of excavation Close planking and strutting shall be done by completely covering the sides of the trench generally with short upright, members called 'poling boards'. These shall be 250x38 mm in section or as directed by the Engineer-in-Charge.

The boards shall generally be placed in position vertically in pairs. One boards on either side of cutting. These shall be kept apart by horizontal walling of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by Engineer-in-Charge. The length and diameter of the ballies strut shall depend upon the width of the trench. Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'wallings' which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the si
des shall be taken in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed. The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in-Charge to be left permanently in position.

Open Planking and Strutting: In case of open planking and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick shall be spaced sufficiency apart to leave unsupported strips of 50 cm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subject to the approval of the Engineer-in-Charge. In all other respect, specifications for close planking and strutting shall apply to open planking and strutting.

During excavation and trenching work etc. the contractors shall ensure compliance to the guidelines in such matter laid down by the authority to ensure that there is minimum hazard to the operating personnel and user, minimum inconvenience to users, minimized damage to the underground plant / services of other utilities in a coordinated way in the interest of public inconvenience and overall safety of the adjoining structures etc.

The Contractor shall be responsible for the design, supply, fixing and removal of all planking and strutting, shoring, etc. required by the Works or as otherwise deemed appropriate by the Engineer.
All such shoring etc. shall be sufficiently strong to resist earth pressure, insure the safety of the workpeople and the works and to prevent damage to any adjoining property. The Contractor at his own expense shall clear any falls of earth into the excavations. The Contractor at his own cost shall similarly carry out any consequential back filling or reinstatement.

6.6.1 Steel Sheet Piling

Necessity: The sides of excavation in foundations whether of shallow or deep, depending on site conditions, shall be protected and taken care of by the Contractor. Steel sheet piles used for protection of sides of excavation shall be driven adequately below excavation levels to give stability. The sheet piles shall be supported at several points, by soldier beams, Wales and struts. Wherever the excavation width is more inclined bracing or rakes shall be provided to support the sheet pile.

Contractors Responsibilities: The Contractor shall submit his plans on sheet piling for the pits and trenches, shoring and strutting system along with the tender. The Contractor shall responsible for the design of the shoring which shall be strong enough to resist side thrust and prevent slips / blows and damage to adjacent works and property. It shall be capable of safe removal when all the items of work for which it is required are completed, without causing damage to adjacent property or the foundations already completed. Adequate protective measures shall be taken to see that the foundation excavation does not affect or damage adjoining structures and sides of foundations. The Contractor shall take all measures required for ensuring stability of the excavation and safety of the property and people in the vicinity.

Shapes of Sheet Piling: Steel piling comprises a row of piles engaging with or interlocked with one another so as to form a continuous wall, which may be a temporary retaining wall to protect the sides of vertical cut for deep foundations or shallow foundation depending on specific site condition. Steel sheet piling shall have suitable joints, which do not deform during driving and shall form a continuous protection wall. The pile length can be increased either by welding or bolting. The shapes of steel sheet piles shall be of straight sheet piling, shallow arch-web piling, arch-web piles and or Z- piles. The deep arch-web and Z-piles shall be used in cases where the large bending moments are to be resisted. Where the bending moments are less, the shallow arch piles with corresponding smaller section module shall be used. Straight-web sheet piles shall be used where the web will be subjected to tension.

Driving steel sheet piles: Steel sheeting shall be driven by a pile frame with hammers or by an automatic double acting hammer suspended from a derrick. The pile shall be guided to an interlock system. A drop hammer or a double acting hammer shall be used for clay and non-cohesive soils such as coarse sand and gravel respectively for non-cohesive soils. Alignment of the piling shall be maintained. Double acting hammers shall be operated either by steam or by compressed air. The operation of a double acting hammer shall be in such a manner that the whole weight of the hammer always rest on the head of the pile. The hammer shall hit directly on the pile or on a suitable head fixed on the pile. Steel sheet piles shall be

interlocked in pairs with helmets. Steel sheet piles with web section shall be reinforced by steel strips bolted or welded on to minimise skin friction on the pile driven in stiff cohesive soil.

Extraction of sheet piles: The driven steel sheet piles shall be withdrawn on completion of foundation, carefully without disturbing / damaging the newly laid foundation or the adjoining area using either double acting hammer fitted with an extracting attachment or an extractor suspended from a derrick.

6.7 Filling

6.7.1 Earth: Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling.

6.7.2 Earth Filling: The space around the foundations and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers not exceeding 20 cm in depth. Each layer shall be atered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

6.7.3 Filling Side of Foundations: The cubical contents of bed concrete leveling course and masonry/ concrete in foundations up to the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earth work to arrive at the quantity for filling sides of foundation. The quantity shall be calculated correct to two places of decimal.

6.7.4 Filling in Plinth and under Floors*:* Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre-measurement correct to the nearest cm and cubical content worked out in cubic meters correct to two places of **decimal.**

6.7.5 Compaction Quality: Compaction of earth and sand filling in areas where foundation & floors are located, the degree of compaction achieved shall be minimum 95% of maximum dry density. As obtained by proctor compaction as per IS: 2720 (Part-IIV). In road and other areas the degree of compaction shall be 90%.

6.7.6 Testing of Filling Layer: After the compaction of each layer, samples shall be taken from compacted layer and tested for dry density as per IS practice. The next layer of filling shall not be permitted until the engineer in charge is satisfied that pervious layer has achieved required compaction. If any particular layer fails to meet the required compaction, it shall be recompacted as directed by the engineer in charge and fresh samples shall be taken to ascertain the compaction density. Such re-compaction shall be continued till the desired compaction is achieved. The thickness of each compacted layer shall not exceed 200mm.

6.8FORM WORK (CENTERING & SHUTTERING)

6.8.1 Form Work: Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

6.8.2 General Requirement: It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

6.8.3Material for Form Work:

6.8.3.1Centering/Staging:

(a) Propping and Centering: All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel. Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made from rolled structural steel sections.

(b) In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

(c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

Shuttering: Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Engineer-in-Charge shall be provided in the joints. Steel shuttering used or concreting should be sufficiently stiffened.

Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250) or as directed by the Engineer-in-Charge, so as to offset the subsequent deflection, for cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

Removal of Form work (Stripping Time): In normal circumstance and where various types of cements are used, forms may generally be removed after the expiry of the following periods:

Type of Form work	Minimum period Before Striking Form work for OPC 43 grade
(a) Vertical form work to wWalls, columns,	

or as directed by EIC Walls, beams	16-24 hr
(b) Soffit form work to slabs (Props to be fixed immediately after removal of formwork)	3 days
(c) Soffit form work to beams (Props to be re-fixed immediately after Removal of formwork	7 days
d) Props to slabs: (1) Spanning up to 4.5m (2) Spanning over 4.5m	7 days 14 days
(e) Props to beams and arches: (1) Spanning up to 6m (2) Spanning over 6m	14 days 21 days

(b)

Note 1: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally, If Portland pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete; the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

Surface Treatment

Oiling the Surface: Shuttering **surfaces** of form work are coated with suitable mould oil which acts both as a parting agent and also gives surface protections.

Inspection of Form Work: The completed form work shall be inspected and approved by the **Engineer** in-charge before the reinforcement bars are placed in position.

6.90 DISPOSAL OF EXCAVATED MATERIALS

(i) The excavated materials suitable for construction shall be stockpiled in areas where permanent works are not located.

(ii) Excavated materials which are not suitable for construction and those in excess of the requirement for construction shall be disposed off in the waste disposal areas as proposed by the Contractor and subsequently approved by the Engineer-in-Charge. Surfaces of material so disposed off shall be trimmed to regular lines and grades satisfactory to the Engineer-in-Charge. Disposal of all materials shall be such that it will not interfere with natural drainage and is as per the regulations for environmental protection; drains will be constructed to prevent the undesirable accumulation of water in or around the disposal area. If additional areas are required, the Contractor shall propose such areas for approval of the Engineer-in-Charge.

(iii) The Contractor shall ensure that no excavated materials are disposed off in the streams or at locations, where in the opinion of the Engineer-in-Charge, these are liable to be washed away by the floods.

(iv) The Contractor shall remove, deposit, spread and level surplus excavated materials after filling where directed within the confines of the site. Rate of excavation shall inclusive of backfilling with the available excavated earth and multiple handling if required.

(v) The Contractor shall take all necessary precautions to prevent any spillages or soiling of the Public Roads during the earth removal operation.

(vi) The contractor shall remove all surplus and unusable excavated earth from the site and dispose to places approved by the local authority at the quoted price.

(vii) All other specifications/stipulations in this regard laid in this document shall also apply.

6.11 DRAINAGE/DEWATERING

Seepage water from springs or rain water shall be suitably collected and drained away by gravity, wherever it is possible to do so. Where, however, drainage by gravity is not feasible, pumping could be resorted.

The Contractor shall keep the excavations well drained and dry at all times and shall take all precautions to prevent surface water from entering the excavations. He shall maintain on the site, at all times, pumps of sufficient capacity to deal with any surface or subterranean water, which may arise from the excavations. The Contractor shall also provide all pumps, hoses and other equipment necessary for the drainage and de-watering.

The Contractor shall allow for the construction of all necessary temporary earth drains, 300 mm half round drains and pipe culverts and the maintenance and temporary diversion or damming of any existing drains. If required, any drains or water course so diverted shall be reconstructed in original position upon completion of the works.

The Contractor shall provide a network of temporary drains to adequately drain the site. The drainage system should comply with the requirements of the appropriate local authorities. The Contractor shall obtain the necessary approvals and pay all costs and expenses in this respect.

The drains shall be sufficiently large so that no mud or water will spill onto the roads or pavements. The Contractor shall also keep the main Authorities drains in the immediate and surrounding areas free from silting up owing to the effluent from the site. If the water is muddy, it will be necessary to place strutted and supported boarding near the exposed surface. The space in between the boarding and the surface shall be filled in with graded stone chippings and coarse sand which will act as a filter to prevent the loss of soil.

The Contractor shall make all arrangements deemed necessary for keeping the excavation and work areas dry for execution of works as per specification.

6.11.1 Well point and deep well pumps

The Contractor shall, when using well points or deep well points for de-watering the site, comply with the following requirements:

The Contractor shall provide full details of the proposed well point or deep-well pump system duly taking into consideration the soil profile and the grain size analysis curve as to permeability characteristics of different layers based on bore hole data for deciding the spacing and size of Steiner pipes.

The Contractor shall conduct preliminary site trials to determine the final layout of the system and verify its effectiveness and shall determine the spacing and depth of the points and the number of stages required based upon these trials. Two stages of de-watering shall however be a minimum.

Withdrawal of stages shall be done as decided by the Engineer. at site, while removal of lowest stage, which is mandatory, shall be only after completion of roof of the lowest basement. The manner of installation of the well points shall not cause weakening or subsidence of either the surrounding area or any slips in nearby slopes. The jetting operation during installation of Steiner shall not cause disturbance to sub-soil stratification.

The Contractor shall install measuring device to determine water head and flow rate for purposes of control. The system shall provide for sufficient valves in leaders and pipes to maintain control over separate sections of the system.

The water table shall be lowered by not less than 10 metre and maintain the level to ensure that the bottom of excavation is reasonably dry till the basement work is completed. Where auxiliary sand drains are installed, they shall be considered an integral part of the system.

The arrangement of the system shall go well with excavation operation and shall have adequate stand by pumps etc.

The contract sum shall be deemed to include for the provisions of paragraphs

6.12BACKFILL

(i) Backfill shall consist of materials as approved by the Engineer-in-Charge and shall be placed in locations as shown on the approved drawings or as directed by the Engineer-in-Charge.

(ii) Earthfill, which on account of its nature or a location requiring no compaction, shall be classified as backfill.

(iii) Backfill which shall be compacted by means of roller, mechanical or manual tampers is classified as compacted backfill.

(iv) At locations, where areas to be backfilled are too small or confined, compaction may be done manually with tampers etc.

(v) Only suitable materials obtained from excavation, if practicable, shall be used for backfill and construction of such features as approach road, causeway etc.

(vi) Material to be used in backfill shall be free draining type.

6.13 ILLUMINATION

The Contractor shall install an adequate illumination system at the work site.

6.14 MISCELLANEOUS WORKS

Besides the above, the Contractor shall also carry out, but not limited to, the following activities:

(i) Excavation for drainage trenches

(ii) Clearing of all trees, bushes, rubbish and any other objectionable materials and their removal and disposal.

(iii) Replacement of survey points fixed by the Engineer-in-Charge which are damaged by Contractor's negligence.

(iv) Formation of berms or ramps, sump pits for installation of dewatering pumps at places which fall beyond the specified excavation lines.

(v) All dewatering and drainage works

(vi) Methods adopted for specially controlled excavation at foundation level or near the faces where plain surfaces are required.

(vii) Replacement or repair of concrete or other works damaged by blasting.

(viii) Draining, shaping and trimming of the dumped material in waste disposal areas to the lines and grades as directed or approved by the Engineer-in-Charge.

(ix) All shoring, strutting and other protective as required during excavation.

6.15 Measurements and Payments

(i) Immediately after the final excavation of foundation or otherwise, inspection and approval of Engineer-in-Charge, levels at salient locations of the foundation pit/trench, etc., shall be measured jointly by the Contractor and the Engineer-in-Charge.

(ii) Interim/progressive payments will be made, in accordance with Clause 14 of the General Conditions of Contract, Volume – II (Part – A), at the appropriate unit rate entered in the Schedule of works which shall include the entire cost of all operations required for execution of the respective item.

7CONCRETE WORKS

7.1SCOPE OF WORK

(i) The specifications described hereunder cover all labour, materials, equipment, plant and services related to the concrete work to be carried out by the Contractor under the Contract.

(ii) The concrete work shall be performed to the dimensions as shown on the approved drawings.

(iii) The approval given by the Engineer-in-Charge to the Contractor's plants and equipment or their operation, or of any construction methods shall not relieve the Contractor of his full responsibility for the proper and safe execution of concrete work or any obligations under the Contract.

7.2SUBMITTALS

(i) Submittals listed herein are related to the items which require the consent of the Engineer-in-Charge and are to be made by the Contractor before the appropriate work may proceed.

(ii) Within 30 days from the date of issue of the Letter of Acceptance, but before procuring or mobilizing to the site, the equipment, the Contractor shall submit to the Engineer-in-Charge, updated and detailed plans and descriptions, consistent with those submitted with his bid and any subsequent amendments and additions agreed to by the Engineer-in-Charge and the Contractor, of the following:

(a) Aggregate Processing Plant

Description, flow diagrams and drawings in sufficient details to indicate layout, type and capacity of crushing, screening, washing, covering and other aggregate processing and handling equipment.

(b) Batching and Mixing Plants

Description, flow diagrams and drawings of the plants and details of the equipment, the Contractor intends to use to determine and control the amount of each separate concrete ingredient and mixing thereof into uniform mixture.

(c) Concrete Cooling Plant

Details of refrigeration and ice plants and other method which the contractor proposes to use to comply with concrete temperature requirements.

(d) Transport and Placing of Concrete

Full details of the equipment and method for transporting the concrete from the concrete plant to the final point of placing, including numbers, type and capacity of transport vehicles, concrete pumps, and details of standby plants to be installed.

(iii) **At least 30 days** in advance of any concrete work being carried out in the site, the Contractor shall submit to the Engineer-in-Charge, following information:

(a) Details of surface finishes, treatment of construction joints and construction techniques which the Contractor proposes to use in order to achieve the required concrete surfaces and allowable tolerances.

(iv) **At least 30 days prior** to procuring or dispatch to the site of the particular item of work to which the submittal relates, the Contractor shall submit to the Engineer-in-Charge.

(a) Details covering the properties and performance, including the certified copies of reports of all tests made by the manufactures of waterstops, expansion joint fillers and joint sealing compounds along with samples of the products.

(b) Details of curing compounds

(c) Details of epoxy mortar for concrete repair

(d) Details of the cooling system for post-cooling of mass concrete.

(v) Drawings showing the location of construction joints proposed by the Contractor which differ from those on the drawings approved by the Engineer-in-Charge, including formwork and reinforcement details, shall be submitted to the Engineer-in-Charge **at least 30 days prior** to the commencement of work on the particular structure.

(vi) During the performance of the concrete work, the Contractor shall keep a diary where he shall record the construction procedures related to concreting. This diary shall be made available to the Engineer-in-Charge upon request. The records shall contain at least the following:

(a) Commencement and termination of concreting of various parts of the structures
(b) Quantities and quality of aggregates and cement provided and the storage from which they were drawn
(c) Temperature of air, water, cement aggregates and concrete
(d) Meteorological conditions and humidity of air
(e) Personnel employed during various stages of the concreting operation and name of the responsible inspector or foreman
(f) Equipment used
(g) Directives received from the Engineer-in-Charge
(h) Any special material or procedures employed
vii) The Engineer-in-Charge reserves the right to ask for any additional information deemed necessary to be included in the submitted documents.

7.3STANDARDS

(i) The concrete material, production methods, testing and admixtures shall conform to the following Indian Standards or, where not covered by these standards, to the equivalent International Standards:

IS : 456 – 2000 -
IS : 1199-1959 -(Reaffirmed 1991)
IS : 457-1957 -(Reaffirmed 1991)
IS : 1972-1989 -

IS : 7861 (Part-I) – 1975-(Reaffirmed 1990)
IS : 7861 (Part-I) - 1981 -(Reaffirmed 1992)
IS : 2505 - 1980-(Reaffirmed 1993)

(ii) In cases of conflict between the above standards and the specification given herein, the specifications shall take precedence.

7.4QUALITY CONTROL AND TESTING

7.4.1General

Field tests for quality assurance and testing of concrete and admixtures shall be performed by the Contractor at regular intervals or as directed by the Engineer-in-Charge. Employer may also carry out the required tests and for this purpose the Contractor shall supply labour, material, equipment necessary to sample and transport materials to the field laboratory from any part of the project area.

7.4.2Test Prior to the Start of Concrete Works (Trial Mix Design)

7.4.2.1 General

(i) Immediately after the Aggregate Processing Plant and Batching and Mixing Plants are established by the Contractor but at least two months prior to the Contractor's programme to commence any concreting of permanent works, the Contractor shall start the testing of materials, conduct various trial mix design of concrete ingredients for the desired strength of different grades of concrete and propose the composition of concrete mixes and prepare trial mix of each of the proposed concrete class. The Engineer-in-Charge may also prepare the trial mixes using the cement, water, aggregates and admixtures intended for the work. Such materials shall be arranged by the Contractor which shall conform to the requirements specified in **"Materials for Construction".**

(ii) The trial tests shall be carried out until the concrete mixes show appropriate strength, workability density, and water tightness without the use of excessive cement. The trial tests shall include determination of the following parameters:
(a) Cement properties
(b) Characteristics of aggregates
(c) Water properties
(d) Admixture properties
(e) Proportion of aggregate ranges in the mix
(f) Proportion of uncrushed to crushed aggregates
(g) Cement dosage
(h) Water-Cement ratio (W/C)
(i) Workability of concrete mixes
(j) Compressive and tensile strength
(k) Entrained air
(l) Density
(m) Water tightness

7.4.2.2 Cement, Aggregates and Water

Cement, aggregates and water will be sampled and tested by the Contractor as set out in **"Materials for Construction".**

7.4.2.3 Concrete

(i) Concrete test cubes shall be prepared and cured in accordance with IS : 456 – 2000. Six test cubes shall be made from the each mix proposed for the different classes of concrete. Compressive strength of concrete will be tested at 7,28 and 90 days.

(ii) The consistency of the proposed mixes shall be tested by means of slump test. Specimen for slump test will be taken from each batch of concrete used to make the test cubes.

(iii) Air content will be determined in accordance with IS : 9103 – 1979.

(iv) Prior to the execution of large scale concreting work at the site, test will be performed to determine the temperature development due to hydration within the concrete with various types of cement. The temperature rise will be recorded and corresponding diagrams established.

7.4.3Tests During Execution of Works by the Contractor

(i) Samples from the concrete being used for the permanent works, taken either at the batching and mixing plant or the placing point, shall be cured and tested hereafter as set out in Para 9.4.2.3.

(ii) In addition to the seven, twenty-eight days strength tests, ninety days strength tests and also at other ages shall be carried out as required by the Engineer-in-Charge.

(iii) Concrete for test specimens for compressive strengths shall be collected at random as it comes out of the mixer or at placing point once every shift or more often as the Engineer-in-Charge may require, and in quantity sufficient to prepare necessary number of test pieces from each sample. The concrete so collected shall be representative sample.

(iv) In addition to the strength tests carried out as above, it is contemplated that tests on actual cores from the concrete laid in position will be made by the Contractor, and results thereof shall be in conformity with those obtained in cube cast at the batching and mixing plant or at the placing point. For this purpose, it may be necessary to establish relationship between concrete strength versus age, as it may be possible to test control cubes and cores of the same age taken from the hardened concrete in the structure. Location and number of cores shall be decided by the Engineer-in-Charge. If the cores taken out show unreasonably low results, the work is liable to be rejected and may be required to be dismantled and re-done with all consequences to the Contractor.

(v) The contractor shall fill the test holes left by the removal of the cores with concrete of the required strength to the satisfaction of the Engineer-in-Charge.

(vi) The Engineer-in-Charge shall at all times, have access to and association with sampling, design and test of trial mixes, tests of strength corresponding to the laboratory tests.

7.5PROPORTIONING OF CONCRETE

(i) All grades of concrete shall be air entrained concrete by using an approved air entraining agent. The air to be entrained shall vary in contents from 2% to 7% as per the laboratory tests.

(ii) Based on the analysis and tests made from time to time during the progress of work on the samples of various ingredients of concrete e.g. cement, aggregates and admixtures, and the resulting concrete, the Contractor will determine and submit to Employer for approval about the quantity of each ingredient to be used in the concrete mix.

7.5.1 MINIMUM LEVEL OF THE CEMENT CONTENT FOR DESIGN MIXES

S.NO	GRADE OF CONCRETE	Cement content / Cum in Kgs for 40mm MSA	Cement content / Cum in Kgs for 20mm MSA
1	M10	220	220
2	M15	280	280
3	M20	340	350
4	M25	370	380
5	M30		420
6	M35		450

7.6HANDLING OF AGGREGATES

(i) The coarse aggregates shall be stacked in three separate stock plies, designated 80 mm to 40 mm, 40 mm to 20 mm and 20mm to 4.75 mm nominal size aggregates. A separate stockpile shall however be made for 150 mm nominal size aggregate.

(ii) If tests reveal the separation of the 10 mm and lower sizes is required, a separate stockpile, shall made for this aggregate.

(iii) The fine aggregate, having the required grading, shall ordinarily be stacked in two piles, one of which is washed and drained and other freshly washed, to minimise the variation in the moisture content.

(iv) Where crushed fine aggregate replaces a part of natural fine aggregate, the two shall be stacked in independent stockpiles.

(v) It may be necessary to have two or three piles, by sizes, in case of natural fine aggregate to get the required grading.

7.7BATCHING AND MIXING

7.7.1Batching and Mixing Equipment

(i) The Batching and Mixing Plant shall be of the requisite capacity to maintain the required progress on different items of work.

(ii) The Plant shall be capable of determining accurately, by direct weighing, the prescribed amount of the various ingredients including water, cement, admixtures and puzzolana etc. and each individual size of aggregate entering the concrete and combining them to give a uniform mix within the prescribed time and discharging the mix without segregation.

7.7.2 Calibration of Measuring Devices

(i) The Contractor shall provide standard test weights and other auxiliary equipment required for checking the operating performance of each scale and other measuring device and shall make periodic tests over the ranges of measurements involved in the batching operation.

(ii) The tests shall be made in the presence of a representative of the Engineer-in-Charge and shall be adequate to prove the accuracy of the measuring devices.

(iii) The frequency of such tests will be determined by the Engineer-in-Charge. Unless otherwise directed, tests shall be made once in two weeks at random without any notice in the case of cement and water scales and once a month in the case of all other scales.

(iv) The Contractor shall make such adjustments, repairs or replacements as may be necessary to meet the specified requirements for accuracy of measurement. The devices shall be capable of being operated to control the delivery of materials so that the combined in-accuracies in feeding and measuring do not exceed the following limits:

S. No.	Material	Percent (by weight)
1	Cement	1
2	Water	1
3	Aggregate	3
4	Admixtures	1

7.7.3 Mixing

(i) All concrete shall be thoroughly mixed in the Batching and Mixing Plants/Tilting batch mixer of an approved type, size and design as to positively ensure uniform distribution of the components throughout the mass during the mixing operations.

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. Unless otherwise authorised by the Engineer-in-Charge for mixers of one cubic metre capacity or less, the mixing of each batch shall continue for 1.5 to 2 minutes after all materials, except the full amount of water, are in the mixer. For mixer of larger capacity, the minimum mixing time shall be increased by fifteen seconds for each additional 0.5 cubic metre.

(ii) The mixing time shall be increased when, in the opinion of the Engineer-in-Charge, the charging and mixing operations fail to result in the uniformity of composition and consistency within the batch to batch.

(iii) Separation of coarse aggregate from mortar shall be avoided by proper arrangement of the discharge so that the concrete falls vertically and not diagonally into whatever container is to receive it.

(iv) Should the last fraction of the batch contain an excessive amount of coarse aggregate, this portion shall be retained and mixed with the succeeding batch.

(v) Discharge pipes of all water batches shall be of such a size and so arranged that the flow into the mixer is completed within the first 25% of the mixing time and delivered well inside the mixer where it is mixed quickly with the entire batch.

(vi) Over mixing requiring additions of water to preserve the required consistency shall not be permitted.

(c)

(vii) On no account shall any addition be made to any component of a concrete batch once that batch has been mixed and discharged from the mixer, whether for the purpose of retempering or any other reason, without the prior approval of the Engineer-in-Charge.

7.8TEMPERATURE OF CONCRETE

Placing temperature of concrete for open works shall be maintained as stipulated in the BIS Codes or as directed by the Engineer-in-Charge. The measures to maintain these temperatures shall, but not, be limited to the following:

(a) Pre-cooling coarse aggregate with refrigerated water or with cold air blasts.

(b) Using cold mixing water by adding ice. Ice, if used, shall preferably be batched by weight, separately from the water. In short time mixing when aggregates are pre-cooled substantially, the ice may not completely melt in the mixer. In such a case, additional mixing time may be required or the amount of ice limited to about 30% of the mixing water.

(c) Using cement having low heat of hydration.

(d) Insulating water supply lines and tanks or at least painting exposed portions white.

(e) Insulating mixer drums or cooling them with sprays.

(f) Shading the batching, mixing and conveying equipment.

(g) Working only at night.

(h) Keeping mixing time and the time required to convey to the point of placement to a minimum.

(i) Spraying foams and reinforcement with water when they are exposed to direct sun light.

(j) Placing concrete in accordance with the procedure set out in IS : 7861 (Part-I) – 1975 (Reaffirmed 1990).

(k) Protecting all freshly placed concrete from exposure to direct sun light.

(l) Employing continuous moist curing.

7.9CONVEYING

(i) Concrete shall be conveyed from mixer to forms as rapidly as practicable by methods, which shall prevent segregation and / or loss of ingredients. In case such separation occurs, concrete shall be remixed before being laid in place.

(ii) The distance between the mixer and the place of concreting and also the mode of transport of concrete shall be subject to the prior approval of the Engineer-in-Charge.

(iii) Concrete shall be deposited in the final position as early as practicable but always **within a period of 30 minutes after mixing**. This limit may be modified by the Engineer-in-Charge to suit working or weather conditions.

(iv) Plants, such as buckets, plant conveyors and/or pumping equipment, which may be used for conveying concrete from mixing plant shall be of such size, design and condition so as to ensure an even and adequate supply of concrete at the placement area.

(v) Particular attention shall be paid to prevent segregation at the ends of chutes /hopper gates and at all other points of discharge.

(vi) Methods of conveying concrete in a thin continuously exposed flow to the forms to any part of the structure shall not be permitted except for very limited or isolated sections of the work, and only when approved in writing by the Engineer-in-Charge.

(d)

(vii) Where chutes are used, they shall be so constructed and arranged as to permit continuous flow of the concrete without separation of the ingredients. Chutes shall not have a slope steeper than 1 V : 2 H.

(viii) There shall be no vertical drop greater than 1.5 m unless warranted, but subject to the approval of Engineer-in-Charge is used to confine and control the falling concrete.

(ix) Concrete may be dropped through flexible elephant-trunk chutes, provided some method is used at the lower end to retard the speed of the falling concrete and prevent it from segregating.

(x) Buckets for transporting concrete shall be manufactured as low-slump concrete buckets.

(xi) The conveying plant shall be kept free from hardened concrete and foreign materials and shall be cleaned at frequent intervals.

(xii) During hot or cold weather, concrete shall be transported in deep containers, on account of their lower ratio of areas to mass, reduce the rate of loss of water by evaporation during hot weather and loss of heat in cold weather.

(xiii) All conveying plants shall be supported independently of the forms, except as specifically permitted by the Engineer-in-Charge.

7.10 PLACING OF CONCRETE

7.10.1 General

(i) No mortar or concrete shall be placed except in the presence of the Engineer-in-Charge.

(ii) The Contractor shall provide Engineer-in-Charge with a weekly placing schedule giving the detailed location of the pours, the approximate extent of pours and the date on which the concrete shall be placed.

(iii) Concrete shall be placed only in locations where authorised and no concrete or mortar shall be placed until formwork, installation of reinforcing steel, steel ribs, piping and other embedded parts, preparation of surface and necessary clean up have been done and checked and certified by the Engineer-in-Charge as being in conformity with specifications and drawings.

(iv) Concrete placed without prior knowledge and approval of the Engineer-in-Charge shall be required to be removed and replaced.

(v) Earth foundations on which concrete is to be laid shall be firm drained soil, free from any soft mud or other objectionable material.

(vi) Whenever concrete is to be placed on earth, a layer of lean concrete of approved proportion shall first be placed before placing concrete of the specified grade. The thickness of such layer of lean concrete shall be as shown on the drawings or as directed by the Engineer-in-Charge.

(vii) No concrete shall be placed in running water. Water shall, generally, not be allowed to flow over freshly poured concrete until final set has been achieved.

(viii) Immediately, before placing concrete, all the surfaces upon which concrete is to be placed 0shall be thoroughly cleaned by the use of high velocity air and water jets or sand blasting, steel brooms, picks or other effective means, satisfactory to the Engineer-in-Charge.

(ix) All pools of water from the surface on which concrete is to be placed shall be cleaned to ensure proper bonding of fresh concrete with the rock surface. The method of disposal of water in working site shall be subject to the approval of the Engineer-in-Charge.

(x) Sufficient mixing and placing capacity shall be provided so that the work may be kept alive and free from cold joints. Formed concrete shall be placed in horizontal layers, avoiding inclined layers and construction joints.

(xi) To get a monolithic placement, it is important that each layer be shallow enough so that the previous layer is still soft and the two layers are vibrated together.

(xii) Concrete shall not be allowed or caused to flow horizontally or on slopes in the forms.

(xiii) Concrete placing on slope shall begin at the lower end of the slope and progress upward, thereby increasing compaction of concrete.

(xiv) In pneumatic placement of concrete, usual high velocity discharges shall be reduced to a point where no separation and scattering of the concrete occurs.

(xv) In order to reduce bleeding, slump shall not be more than necessary to achieve proper placement and consolidation.

(xvi) All care shall be taken to avoid separation of coarse aggregate from the concrete. Obvious groups and clusters of separated coarse aggregates shall not be permitted. They shall be removed before the concrete is placed over them, otherwise they may cause serious imperfections in the finished work. Hence particular attention shall be paid to the tendency for objectionable separation to occur at the points of discharge so that uniformity and homogeneity of concrete in placement and good workmanship is assured.

(xvii) The concrete shall drop vertically into the centre of whatever container receives it. To protect the roads, spacers, and embedded features from damage and to prevent displacement of reinforcement, concrete falling in forms shall be confined in a suitable drop chute.

7.10.2 Preparation for Placing of Concrete

(i) All surfaces on which or against which concrete is to be placed, including surface of construction joints between successive concrete placement, reinforcing steel and embedded parts, shall be thoroughly cleaned of dirt, mud, debris, grease, oil dried mortar or grout, laitance, loose particles or other deleterious matter.

(ii) Surface seepage and other water shall be so controlled, to the satisfaction of the Engineer-in-Charge, that no time during the placement or hardening of the concrete will it wash, mix with, or seep into the concrete.

7.10.3 Concrete Placement

(i) The method and equipment used for placing concrete shall be such as shall permit the delivery of concrete of the required consistency into the work without objectionable delay, segregation, porosity of loss of workability.

(ii) All surfaces of forms and metal work including reinforcement bars that have become encrusted with dried mortar or grout from concrete previously placed, shall be cleaned of all such matter or grout before the surrounding or adjacent concrete is placed.

(iii) Concrete shall be placed in lifts as shown on the drawings or as directed by the Engineer-in-Charge.

(iv) In reinforced concrete work, which have congested parts, care shall be taken to see that all the bars are properly embedded and that no voids are left. On flat, horizontal surfaces, where the congestion of steel near the forms makes placing difficult, a mortar of the same cement sand ratio as is used in the concrete shall be first deposited to cover the forms.

(v) After the surface have been prepared, all approximately horizontal surfaces or rock and construction joints shall be coated with cement slurry of water cement ratio approximately of 0.60 by weight or as directed by the Engineer-in-Charge. It shall then be covered with layers of mortar approximately 50 mm to 75 mm thick for rock surface and approximately 15 mm thick for construction joints. The mortar shall have the same proportion as that of concrete mix unless otherwise prescribed by the Engineer-in-Charge. The consistency shall be suitable for placing and working in the manner hereinafter specified. The mortar shall be spread uniformly and thoroughly with stiff brooms into all irregularities of the surfaces. Concrete shall then be immediately laid upon the fresh mortar.

(vi) No concrete shall be placed in running water or during rain, high winds, dust storms, excessive heat or cold and similar conditions without prior approval of the Engineer-in-Charge.

(vii) In all cases, concrete shall be deposited as nearly as practicable directly in its final position and shall not be caused to flow by vibrators or otherwise in a manner which shall permit or cause segregation.

(viii) The maximum time internal between placing successive layers within a lift shall not exceed 30 minutes. However, depending upon job requirements and climatic conditions, the Engineer-in-Charge can allow to increase this time interval using appropriate methods of vibration/agitation.

(ix) Concrete shall not be piled up in the forms in a manner that causes movement of the unconsolidated concrete, or permit mortar to escape from the coarse aggregate.

7.10.4 Rate of Placing of Concrete

(i) Concreting shall be done as a continuous operation until the structure or section is completed or until a satisfactory construction joint can be made. The Contractor shall make all arrangement necessary to maintain continuity of concrete placing in any particular pour during meal periods, shift changes, or any other such interruptions.

(ii) Concrete shall not be placed faster than the placing crew can compact it properly.

(iii) In placing thin members and columns, precaution shall be taken against too rapid placement which may result in movement or failure of the form due to excessive lateral pressure. An interval of at least 24 hours, unless otherwise approved or directed by the Engineer-in-Charge, shall elapse between the completion of columns and walls and the placing of slabs, beams or girders supported by them.

(iv) The rate of placing shall be such as to have no objectionable effect on placement of concrete, particularly near forms and in and around embedded equipment where the rate shall not exceed the limit placed by the Engineer-in-Charge.

7.10.5 Consolidation of Concrete

(i) Consolidation of newly placed concrete shall ordinarily be done with internal vibrators of approved design. The equipment of vibration shall have adequate power and shall be of high frequency, rugged and reliable.

(ii) Operators of vibrators shall be experienced, competent in handling these devices.

(iii)Ample stand-by-units and parts as well as systematic servicing shall be provided.

(iv)Vibrators shall not be used to cause concrete to move more than a short distance laterally, otherwise fine wet material may run ahead and separate from the coarse aggregate.

(v) Inadvertent or unintended revibration of concrete is beneficial provided the concrete becomes momentarily plastic again during revibration. Revibration shall be resorted to only after specific instructions are given by the Engineer-in-Charge.

(vi) Where Vibrator is used to full advantage for consolidation of newly placed concrete, no supplementary rodding or other working of the concrete is necessary.

(e)

(vii)Concrete shall be compacted and worked into all corners and angles of forms, obstructions, blockouts, locations with congested reinforcement and around embedded items. Special care shall be taken to attend to these places with ample, properly applied additional vibration or rodding as the case may be, without permitting the concrete materials to segregate.

(viii)Internal vibrators of approved weight and frequency 7000 to 9000 r.p.m. to secure maximum consolidation shall be used.

(ix)External from vibrators of an approved type shall be used only in inaccessible locations and where it is impracticable to use immersion type vibrators after their use has been specifically authorised by the Engineer-in-Charge. The form shall be designed to receive vibrations without losing shape and causing leakage of mortar.

(f)

(x) The immersion type mechanical vibrators, complying with **IS : 2505-1980**, electric, air driven of diesel, shall generally be inserted vertically and the vibrating head shall be allowed to penetrate under the action of its own weight. In very shallow concrete, some consolidation can be obtained by using vibrators in horizontal position.

(g)

(xi)Internal vibrators, when used, shall be inserted at regular intervals and vibration, with the vibrator fully into the layer being compacted, shall be continued till acceptable degree of compaction has been achieved taking care to avoid excessive paste and laitance.

(xii)The entire depth of new layer of concrete shall be vibrated and ordinarily the vibrators should penetrate the layer below (which has not yet become rigid) for several millimeters to ensure thorough bond between the layers.

(xiii)Under ordinary job conditions, there is little likelihood of damage from direct revibration of lower layer or by vibration transmitted by embedded steel provided the disturbed concrete still is or again becomes plastic. Vibrators shall not, however, be inserted into lower courses that have commenced final set nor shall they be directly applied to or allowed to disturb reinforcement extending into hardened or partially hardened concrete.

(xiv)Systematic spacing of points of vibrators shall be established to ensure that no portions of the concrete are missed. It shall be ensured that zones of influence overlap and the concrete is properly consolidated.

(xv) In compacting the surface of a concrete lift, the coarser particles of the aggregate in the surface shall be embedded while the concrete is being vibrated, but the surface left with the desired degree of roughness.

(xvi) Disturbance of the surface concrete at construction joints during early stage of hardening shall be on timber walkways constructed so as not to cause injury to the concrete.

(xvii) When smooth surfaces are required, for all surfaces which shall be permanently exposed to the weather and for all surfaces next to embedded metal work around which it is desired to prevent leakage, the adjacent concrete shall be properly vibrated, spaded or tamped.

(xviii) To ensure even and dense surfaces which are free from aggregate pockets, honey combing or air holes, it may be necessary to supplement internal vibration with hand spading or tamping all along the boundaries of the concrete and around embedded parts, while the concrete is plastic under vibrating action.

7.11 Concrete in R.C.C. Frames/Walls/Slabs

(i) Concrete shall be placed in lifts of heights as shown on the approved construction drawings or as directed by the Engineer-in-Charge. Within each lift, concrete shall be deposited in approximately horizontal layers about 40 cm in thickness unless otherwise directed by the Engineer-in-Charge.

(ii) At locations where lift heights are not shown on the drawings, the Contractor shall submit to the Engineer-in-Charge for approval, details of the placing procedure which he proposes. No concrete shall be placed at such locations without the prior approval of the Engineer-in-Charge.

(iii) Slabs shall be placed in one lift unless otherwise indicated or directed by the Engineer-in-Charge.

(iv) In walls, lifts shall terminate at such levels as will conform to the structural requirements.

(v) The placement of concrete shall be carried out at such rate and in such a manner that the formation of cold joints is prevented.

(vi) Where slabs and beams are placed continuously with walls and columns, the concrete in walls and columns shall have been in place for at least 2 hours or for a longer period when so directed by the Engineer-in-Charge before placing concrete in the slabs and beams.

7.11.1 Concrete for Blockouts

(i) Blockouts for gate guides, seals or tack assemblies of the like shall be provided as indicated on the drawings.

(ii) After the assemblies have been installed and adjusted, the blockout recesses shall be filled with concrete as specified on the approved construction drawings or as directed by the Engineer-in-Charge.

(iii) Before installing the components to be embedded in blockout concrete and before depositing mortar or concrete, the surfaces of the blockout shall be cleaned in the manner specified for cleaning construction joints.

(iv) Exceptional care shall be taken in placing mortar or concrete in the blockouts to ensure satisfactory bond with the concrete previously placed and to secure complete contact with all components embedded in the blockouts.
(h)

7.11.2 Concrete Deposited Under Water

(i) Concrete shall be deposited in water only with the prior approval of the Engineer-in-Charge.
(ii) Concrete placed underwater shall be deposited by a tremie or by a valved tremie.

(iii) The methods and equipment used shall be subject to the prior approval of the Engineer-in-Charge.

(iv) Concrete buckets shall not be permitted for underwater placement of concrete.

(v) The tremie seal shall be affected in a manner which will not produce undue turbulence in water around the pipe. The discharge end shall be kept submerged continuously in the concrete and the concrete pumped in without interruption until the concrete has been brought to the required height.

(vi) The tremie shall not be moved horizontally during a placing operation and a sufficient number of tremies shall be provided so that concrete does not have to flow horizontally, a distance of more than 3 metres.

7.12 CHIPPING AND ROUGHENING OF CONCRETE SURFACES

(i) Surface upon or against which additional concrete is to be placed shall be chipped and roughened to a depth of not greater than 25 mm.

(ii) The roughening shall be performed by chipping, sand blasting or other satisfactory methods and in such manner as not to loosen, crack or shatter any part of the concrete beyond the roughened surface.

(iii) After being roughened, the surface of the concrete shall be cleaned thoroughly of the loose fragments, dirt and other objectionable substances and shall be sound and hard and in such condition as to assure good mechanical bond between old and new concrete.

(iv) All concrete which is not hard, dense and durable shall be removed to the depth required to secure a satisfactory surface.

(v) Prior to placement of new concrete against the old concrete surfaces and the concrete surfaces over which flood has passed shall be chipped and roughened to a depth of not greater than 25 mm or sand blasted to make them clean and free from loose materials/laitance, oil, grease, etc. so as to develop good bond between the old concrete and new concrete.

(vi) Just before placement of concrete, the rock/concrete surface shall be cleaned by high velocity water jet (about 5 kg/cm^2 at the nozzle) followed by careful blowing of high pressure air jet so as to make the surface free from dirt, mud, debris, grease, oil, laitance, grout, loose particles and other deleterious matter. Contractor shall also use picks, wire brushes, if necessary for cleaning. All pools of water shall be removed from depressions.

7.13 DEFECTIVE AND DAMAGED CONCRETE

Concrete which is damaged from any cause and which is not manufactured, placed and compacted in accordance with these specifications and is found to have lower strength, density etc. than specified, as determined from test samples or core samples, shall be removed and replaced by the Contractor.

7.14 FINISHING OF CONCRETE

7.14.1 Finishing of Formed Surfaces

Except as otherwise specified or directed, all permanently exposed concrete surfaces and other waterway surfaces requiring durability under water shall be finished in the following manner:

(i) Any damage to finished concrete resulting from the action of removing formwork or from any other cause shall be repaired to the satisfaction of the Engineer-in-Charge. Immediately on removal of the form, the surface shall be examined and all porous honeycombed or defective concrete removed and repaired as specified herein.

(ii) All imperfections or ridges due to joints in the formwork, shall be removed by light chipping or grinding down if necessary, to produce a smoother surface.

(iii) When the treatment of a surface has been completed, the surface shall be cured.

(iv) All patches and mortar filled pits on exposed surfaces shall be neat and of the same colour and texture as the adjoining concrete.

(v) The finished surfaces concrete shall be true, sound, smooth and free from fins, offsets, pits, depressions, voids, blemishes and other defective concrete and surface irregularities and shall be in accordance with the requirements for the particular class of finish specified herein or as shown on the drawings.

(vi) Finishing work shall be done only by skilled workman in the presence of the Engineer-in-Charge and shall be performed within 4 weeks of placing.

(vii) Before final acceptance of the work, Contractor shall clean all exposed concrete surfaces of all encrustations of cement, mortar or grout, to the satisfaction of the Engineer-in-Charge. Concrete shall not be considered finished until all required repair work and finishing have been completed.

7.14.2 Finishing of Unformed Surfaces

Unformed surfaces shall be finished by one or more methods of screeding, floating and trowelling and working of the surfaces shall be done at the proper time, employing experienced men and shall be just sufficient to produce the desired finish.

(i) Screeding

(a) It gives the surface its approximate shape by striking off surplus concrete immediately after completion and shall be accomplished by moving a straight edge or template with a swing motion across wood or metal strips which have been established as guides.

(b) Where the surface is curved, a special screed shall be used.

(ii) Floating

Shortly after the concrete is screeded, the surfaces shall be brought true to from and grade by working it sparingly with a wooden float. If a coarse textured finish is specified or if the surface is to be steel trowelled, a second or final floating shall be performed after some stiffening has occurred and the surface moisture film or shine has disappeared.

(iii) Trowelling

(a) If a smooth dense finish is desired, floating shall be followed by steel trowelling some time after moisture film or shine has disappeared from the floated surfaces and when the concrete has hardened sufficiently to prevent fine material and water from being brought upto the surface. Excessive trowelling at an early stage as would tend to produce creaking or result in a surface that is too hard to finish properly shall be avoided.

(b) Trowelling shall, therefore, be done at the appropriate time and shall have the surface smooth, even and free of trowel marks and ripples. A fine textured surface that is not slick shall be obtained by trowelling lightly over the surface with a circular motion keeping the trowel flat on the surface of the concrete. Where a hard steel trowelled finish is required, trowelling shall be continued until it no longer produces noticeable compaction and the surface has a glossy appearance, trowelling pressure being increased gradually as the operation progresses.

(c) The use of any finishing tool in areas where water has accumulated shall be prohibited. Operation on such areas shall be delayed until the water has been absorbed or has evaporated or has been removed by draining, mopping or other means.

(d) All joints and edges on unformed surfaces, that shall be exposed to view, shall be finished with suitable moulding tools with rounded, bevelled or filleted edge, as directed by the Engineer-in-Charge. Unless the use of other slopes or level surface is indicated on the drawings as directed, narrow surfaces such as top of walls or tunnel portals shall be sloped approximately 9 mm per 300 mm of width. Broader surfaces as walls, roadways, platforms and decks shall be sloped approximately 6 mm per 300 mm.

(e) Where separate floor finish is specified or directed, the concrete shall be struck of sufficiently below grade to allow for the subsequent placing of a finished floor. The surface of such concrete shall be left rough.

(f) As soon as the condition of the base permits and before it has hardened fully, all dirt, laitance and loose aggregate shall be removed from the surface, by means of water jets and wire brooms leaving the coarse aggregate slightly exposed and the surface made suitable for taking further concrete.

7.14.3 Tolerance for Concrete Construction

(i) General

(a) The contractor shall construct all concrete structure to the exact lines, grades and dimensions established. However, inadvertent variations for the established lines, grades and dimensions shall be permitted to the extent set forth herein, provided, that the Engineer-in-Charge reserves the right to diminish the tolerances set forth herein if such tolerances impair the structural action or operational function of the structure.

(b) Where tolerances are not stated in the specifications or on the drawings for any individual structure or features thereof, permissible deviations shall be interpreted in conformity with the provisions of this paragraph.

(ii) Tolerance for Surface Finishes

(a) Surface finishes shall generally conform to the types and tolerances indicated in the table given below, unless otherwise specified on the drawings or as required by the Engineer-in-Charge.

(b) Positive tolerance shall be measured outside and negative inside the lines and grades defining the structure on the drawings.

Type of Finish	General Area of Application and method of Forming	Tolerance (mm)
1	2	3
F1	Formed surfaces of construction joints and other surfaces which shall not be permanently exposed. The surface shall required no treatment after form removal, other than repair of defective concrete and specified curing, or treatment as specified for construction joints.	+ 10 - 10
F2	All permanently exposed formed surfaces for which type F3 finish is not specified. Form sheathing or lining shall be placed so that joint marks on the concrete surface shall be in general alignment, both horizontally and vertically and conform to a standard pattern. Immediately on the removal of forms, all unsightly ridges of fines shall be removed; all holes left by removal of ends of form roads shall be neatly filled with mortar and surfaces treated to meet the required tolerances by tooling and rubbing.	+5 -5
F3	Formed surfaces which shall be exposed to flowing water shall be hard, smooth and dense, free from offsets, pits, voids, air holes and irregularities, and shall be chipped, ground and thoroughly cleaned as	+5 - 5

Type of Finish	General Area of Application and method of Forming	Tolerance (mm)
1	2	3
	necessary to conform to the required tolerances.	
U1	Unformed, screeded surfaces which shall be covered by fill materials, static water or concrete. Type U1 finish shall be used as the first stage of type U2 and U3 finishes. Finishing shall consist of sufficient levelling and screeded to produce an even, uniform surface meeting the required tolerance.	+ 10 - 10
U2	Unformed surfaces not permanently concealed by fill or concrete or not required to receive Type U3 finish. (Type U2 finish shall be used as the second stage of Type U3 finish). Floating by means of hand or power driven equipment shall be started as soon as the screeded surface has stiffened sufficiently and shall be the minimum necessary to produce a surface that is free from screed marks and uniform in texture if type U3 finish is to be applied, floating shall be continued until a small amount of mortar without excess water is brought to the surface so as to permit effective trowelling.	+5 - 5
U3	Unformed, screed surfaces which shall be exposed to flowing water. This finish shall be applied by steel trowelling after the concrete has hardened enough to prevent excess of fine materials and water from being brought to the surface free from blemishes, ripples and trowels marks. After the surface has nearly hardened, it shall be trowelled once more until the surface is hard and glossy in appearance.	+3 - 3

7.15 EMBEDMENTS IN CONCRETE

7.15.1 Embedded Parts

(i) Before placing concrete, care shall be taken to ensure that all embedded parts are firmly and accurately fastened in place as indicated on the drawings or as directed.

(ii) All embedded parts shall be thoroughly cleaned, free from all foreign matter such as scale, rust, oil, etc.

(iii) Concrete shall not be placed on embedded parts unless these are checked and approved by the Engineer-in-Charge.

(iv) Parts of gates, gate hoists, valves, operating machines and other control equipment as also the anchor bolts, structural steel plates and bearings shall be installed/embedded in concrete/rock as shown on the drawings or as directed.

(v) Embedded parts for pump and other equipments as needed will be supplied to the Contractor and the same shall be embedded in concrete as shown on the drawings or as directed by the Engineer-in-Charge.

(vi) If concrete is placed by the without correctly placing in position, the necessary embedded parts, concrete shall have to be removed and replaced to enable such embedded parts to be installed in position.

(vii) Care shall be taken not to disturb or displace embedded parts during concrete placement.

7.15.2 Water Stops

(i) Polyvinyl Chloride (PVC)/rubber water stops of width and section as shown on the drawings approved for construction shall be furnished and installed for water tight construction at various locations of concrete structures/components covered under these specifications. In order to ensure proper alignment and fixing of water-stops in correct position/place, the same shall be rigidly secured to the formwork or reinforcement steel as directed/approved by the Engineer-in-Charge. Number of joints in PVC/ water stops, when installed in place shall be the barest minimum and joints, thus made, shall be suitably vulcanised/welded by the use of best method/engineering practice satisfactory to the Engineer-in-Charge. The PVC water stop shall be properly protected from sunrays and weather.

(ii) All types of water stops shall be tested as per IS : 8543 in a recognised laboratory prior to transport to the site. Test specimens shall be furnished by the manufacturer and the tests shall be carried out at the manufacturer's place.

(iii) Water stops shall be tested as to their tensile strength, elongation, tear resistance, stiffness, water absorption, gravity, effect of alkali and impact resistance etc.

(iv) The Contractor shall submit to the engineer for approval the test result from recognised institution showing that the material supplied meets the requirements specified. The Engineer may carry out the additional tests, for which the Contractor shall supply specimens from the same material to be used in the work. Test specimens, if required, shall be of the shape and dimensions as required in the individual tests methods.

7.16 EXPANSION AND CONTRACTION JOINTS

i. Expansion and contraction joints shall be constructed at such points and of such dimensions as indicated on the drawings or as required by the Engineer-in-Charge. The method and material used shall be subject to the approval of the Engineer-in-Charge.

ii. Standard bitumen sheets, impregnated with saw dust or any other filler material and sealing compounds, required to be placed in the expansion joints, shall be fixed in position as shown on the drawings or as directed by the Engineer-in-Charge.

7.17 CURING AND PROTECTION OF CONCRETE

(i) Plant and materials required for curing and protection of concrete shall be available at the location of each concrete placement before concrete placement is started and the water used for curing shall meet the requirement set out in these documents.

(ii) All concrete shall be protected against injury until final acceptance.

(iii) Exposed finished surfaces of concrete shall be protected from the direct rays of the sun for at least 72 hours after placement.

(iv) Fresh exposed concrete shall also be protected from the action of the rains, flowing water and mechanical injury.

(v) No fire shall be permitted in direct contact with concrete at any time.

(vi) Concrete in which standard Portland cement is used shall be kept continuously moist for not less than 14 days for normal concrete and 21 days for concrete containing puzzolana, by covering with water saturated materials or a system of perforated pipes, mechanical sprinklers or porous hose or by any other approved method. Curing period where special cement may be used shall be as approved by the Engineer-in-Charge.

(vii) Construction joints shall be cured in the same manner as the other concrete and shall also, if practicable, be kept moist for at least 72 hours prior to the placing of additional concrete upon the joint.

(viii) Horizontal surfaces shall be cured by sprinkling water or by covering with damp sand or may be cured by the use of wet quilts or mats which will satisfactorily supply the required curing water. If damp sand or quilt is used for curing, it shall later be completely removed. The time of applying damp sand shall be specified by the Engineer-in-Charge before which curing shall be carried out by other approved methods.

(ix) The method of keeping formed concrete surface moist shall be continuous sprinkling or spraying of water as may be necessary to prevent any portion of the surface from drying during the specified period.

(x) The water and other methods of curing shall be so handled as not to stain concrete surfaces, which shall be exposed.

(xi) The actual method of curing adopted shall be subject to the approval of the Engineer-in-Charge.

(xii) The contractor shall have on hand and ready to install before actual concrete placement is started, all equipment needed for adequate curing and protection at all locations of concrete placement.

(xiii) In limited areas and for special purposes, the use of an approved and properly applied compound may be permitted at the discretion of the Engineer-in-Charge to restrict the evaporation of the mixing water. Such curing compound shall be of the surface membrane type which will thoroughly seal the surface. Curing compound shall not be used on joints where bonding is required.

(xiv) Curing compounds shall be applied according to the manufacture's recommendations to provide a continuous uniform membrane over all areas. Curing compounds shall be applied only after moist curing has been carried out for at least 24 hours.

(xv) A curing compound shall not be used on any unformed surface where, in the opinion of Engineer-in-Charge, the irregularities in that surface would prevent the membrane forming an effective seal, on any surface which has a temperature lower than manufacturer's recommended application temperature, or any surface where a bond is required for additional concrete, or where a curing compound is placed on a surface where a bond is required, it shall be removed by sand blasting or by other means satisfactory to the Engineer-in-Charge.

(xvi) Curing membranes shall be protected from damage at all times.

(xvii) Care shall be taken not to disturb the steel reinforcement projecting from any placement for at least 24 hours after the completion of such placement.

(xviii) Finished concrete surface shall be protected from stains or abrasion and surface of edges likely to be injured during the construction period shall be kept properly protected by leaving forms in place or erecting protective covering satisfactory to the Engineer-in-Charge.

(xix) In case, the curing operations are inadequate or unsatisfactory, the Engineer-in-Charge shall be entitled to take such steps as he may deem necessary to make good the deficiencies and defects.

7.18 REPAIR OF CONCRETE

(i) Repair of concrete shall be performed by skilled workmen and in the presence of the Engineer-in-Charge.

(ii) No repair work shall be carried out until the Engineer-in-Charge, has inspected the location of the proposed repair and accepted the method of repair.

(iii) The Contractor shall correct all imperfections on the concrete surfaces as necessary to produce surfaces that shall conform to the required standards.

(iv) All materials, procedures and operations used in the repair of concrete shall be subject to approval by the Engineer-in-Charge.

(v) Surfaces of concrete finished against forms shall be smooth and free from projections. Immediately upon the removal of forms and within 24 hours thereof, wherever practicable, all unsightly ridges or fines shall be removed and any local bulging on exposed surfaces shall be remedied by tooling and rubbing. All holes left by the removal of fasteners from the tie rods shall, after being reamed with a toothed reamer, be neatly filled with dry pack mortar.

(vi) All honeycombed, porous, fractured or otherwise defective concrete and surface concrete in which, in the opinion of the Engineer-in-Charge, additions are required to bring it to the prescribed lines, shall be removed by chipping concrete.

(vii) The chipped openings shall be sharp edged and keyed, and shall be filled to required lines with fresh concrete or as found suitable. Where concrete is used for filling, the chipped openings shall be not less than 100 mm in depth and the fresh concrete shall be reinforced and dowelled to the surface of the openings as directed by the Engineer-in-Charge.

(viii) Dry pack mortar shall consist of one part of cement to two parts of sand by volume and just enough water so that the mortar as used sticks together on being moulded into a ball by slight pressure of the hands and does not free water when so pressed but leaves the hands damp. The mortar shall be fresh when placed and any mortar that is not used within 30 minutes, after preparation shall be wasted with all consequences to the Contractor.

(ix) The mortar shall be placed in layers not more than 25 mm thickness after being compacted and each layer shall be thoroughly tamped to the satisfaction of the Engineer-in-Charge. Each layer except the last shall be roughened thoroughly to provide effective bond with the succeeding layers. The last or finishing layer shall be smoothened to form a surface continuous with the surrounding concrete. Dry pack mortar shall be used for filling behind reinforcement or for filling holes that extend completely through a concrete section. Shotcrete shall be used for holes too wide for dry pack mortar filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest to the surfaces.

(x) All patches shall be bonded thoroughly to the surface of the chipped openings and shall be sound and free from shrinkage cracks and trummy areas.

(xi) Concrete surfaces where high velocity flows may occur and as required by the Engineer-in-Charge, repair to the surfaces having F3 and U3 finishes shall be bonded with an epoxy adhesive acceptable to the Engineer-in-Charge.

(xii) All repairs to the surface of concrete for flowing water shall be ground smooth to meet the tolerances set out in the specifications

7.19 CONSTRUCTION JOINTS

(i) Concrete surfaces, which become so rigid, by reason of limitations in the rate of placing of concrete imposed by these specifications or by reason of delays in construction progress, that in the opinion of the Engineer-in-Charge, the new concrete cannot be integrally incorporated with that previously placed, shall be defined as construction joints.

(ii) Construction joints shall be located in the positions shown on the approved drawings or as directed by the Engineer-in-Charge and the Contractor shall not be permitted to make any additional joints or deviate from the joints indicated on the approved drawings without the written authorisation of the Engineer-in-Charge.

(iii) Joints at exposed surfaces of concrete shall be straight and continuous, as shown on the drawings or otherwise directed.

(iv) The concrete of the earlier pour shall be hacked to produce a rough surface or green cut with air-water jet or by sand blasting after the concrete has hardened sufficiently as directed by the Engineer-in-Charge. Before placing new concrete, the surface shall be restored to the condition existing immediately after hacking or green cutting by means of another washing with air-water jet, vigorous brushing, sand blasting etc.

(v) All the joints shall be cleaned by the Contractor, to the satisfaction of the Engineer-in-Charge. All intersections of construction joints with concrete faces, which will be exposed to view, shall be made straight, level and in plumb.

(vi) All exposed construction joints shall conform to the requirements of aesthetic and their pattern shall be subject to the approval of the Engineer-in-Charge. Surfaces of the construction joints, which have been permitted to dry by reasons of the succeeding layer not placed within the specified moist curing period, shall be kept moist for at least 72 hours prior to placing the succeeding layers.

(vii) Horizontal construction joints shall be arranged wherever possible to coincide with joints in the formwork.

(viii) To prevent feather edges, the construction joints at the tops of horizontal lifts near sloping exposed concrete surface shall be inclined near the exposed surface so that the angle between such inclined surface and the exposed concrete surface shall not be less than 50 degrees.

(ix) When the work has to be resumed on a surface which has hardened, such surfaces shall be roughened and new concrete placed after taking all measures mentioned in Para 9.10.3 hereof.

(x) The use of a retarder shall not relieve the Contractor of the responsibility of producing surfaces at construction joints as specified and to the satisfaction of the Engineer-in-Charge.

(xi) Disturbance of surface concrete at the joints shall be avoided during the early hardening period. Before placing the succeeding layer, the surface of the construction joint shall be thoroughly cleaned and loose, defective or fractured concrete shall be removed satisfactorily.

7.20 OTHER RELATED EXPRESS

Besides the above, following items including others shall be carried out by the Contractor:

(i) Collection of seepage water or water inflow from the surrounding work site and diverting it into the drainage systems to maintain working area dry during execution.

(j) Developing alternative sources of aggregates by the Contractor and the resulting additional material testing.

(k) Pumping of the Concrete and plasticizers.

(l) Replacement or repair of concrete damaged during blasting carried out by the Contractor.

(m) Making stockpiles for coarse and fine aggregate.

(n) Forming expansion and contraction joints including making drainage and other holes where such joints occur.

(o) Filling of holes left by the removal of concrete cores with the concrete of the same grade.

7.21MEASUREMENT AND PAYMENT

Measurement of concrete work shall be made for making progressive payments against the total contract price using the agreed item rates entered in the contract document.

8STEEL FOR REINFORCEMENT

8.1COPE OF WORK

The specifications described hereunder relate to the work which includes all labour, materials, equipment and services required for the supply, handling, storing, cutting, bending, cleaning, placing and fastening into position all reinforcing steel as shown on the drawings, to be carried out by the Contractor under this contract.

8.2 SUBMITTALS

(i) **Within 30 days** from the date of issue of the Letter of Acceptance, but before procuring the equipment or mobilisation to the site, the Contractor shall submit to the Engineer-in-Charge, the description and drawings showing the sufficient details of the layout and capacity of the equipment proposed for the fabrication of reinforcing steel.

(ii) **At least 30 days** in advance of the reinforced concrete works being carried out on the site, the Contractor shall submit to the Engineer-in-Charge for approval, detailed bar list and bending diagrams showing the number, size, length and bending of all bars required for various parts of the work on the basis of the reinforcement drawings approved by the Engineer-in-Charge from time to time during the progress of works.

(iii) The Engineer-in-Charge reserves the right to ask for any additional information deemed necessary to be included in the submitted documents.

8.3 STANDARDS

(i) The cutting, welding, placement and binding of reinforcing steel shall conform to following Indian Standards or, where not covered by these standards, to their equivalent International Standards.

IS : 456-2000
IS : 1786-1985 (Reaffirmed 1990)
IS : 2502-1963 (Reaffirmed 1990)
IS : 2751-1979 (Reaffirmed 1992)
IS : 9417-1989

(ii) In case of conflict between the above standards and the specifications given herein, the specifications shall take precedence.

8.4 GENERAL

(i) Steel for reinforcement shall conform to the standards and requirements outlined in the **Section on "Materials for Construction".**

(ii) Cutting, bending, cleaning, placing and fastening in position of the reinforcement steel shall conform to the requirements of relevant Indian Standards and as shown on the drawings.

(iii) Transportation and storage of reinforcing steel shall conform to the requirements outlined.

8.5 FABRICATION

(i) All bars shall be cut and bent in accordance with the bar bending schedules approved by the Engineer-in-Charge.

(ii) Reinforcing steel bars shall be cut and bent on the site of the works.

(iii) Reinforcing steel shall not be straightened or rebent in a manner that will damage the materials. Bars with kinks or bends other than those indicated on the drawings and schedules shall not be used.

(iv) Shorter lengths of steel shall not be used in places where continuous lengths are required as per the drawings without the approval of the Engineer-in-Charge. Shorter bars, if approved for use, shall be lapped or spliced to achieve continuity in accordance with the requirements of relevant Indian Standards or as approved by the Engineer-in-Charge.

(v) Bars shall be bent cold to the shape and dimensions shown on the drawings using a bar bender operated by hand or power to attain the proper radii of bends.

(vi) A hook at the end of the M.S. bar, if used, shall have an inner diameter not less than four times the diameter of the bar and shall have length of straight part beyond the curve of at least four times the diameter of the bar. Hooks shall be used only where shown on drawings or as required by the Engineer-in-Charge. The radii of bends for stirrups and ties shall not be less than twice the diameter of the bar.

(vii) Heating of reinforcement bars to facilitate bending shall not be permitted.

(viii) The reinforcement available from rejected concrete shall not be used without prior approval of the Engineer-in-Charge.

8.6 PLACING

(i) Before being placed in position, the reinforcing steel shall be thoroughly cleaned of loose mill scale and rust, grease, paint, or other coatings that would reduce bond. All splashed concrete which has dried on reinforcing steel shall be removed.

(ii) Reinforcing steel to be incorporated in the works shall be placed accurately in position as shown on the drawings and shall be held firmly in place during the placing and setting of the concrete.

(iii) Reinforcing steel shall be placed such that there will be a clear distance of at least 50 mm between the reinforcing steel and anchor bolts or embedded metal work.

(iv) Reinforcing steel shall be maintained in position by the use of small concrete blocks, steel chairs, steel spacers, steel hangers and other steel supports and ties, acceptable to

the Engineer-in-Charge at sufficiently close intervals so that they do not either sag between supports or be displaced during placing of concrete or by any operation on the work. Wood supports or spreaders shall not be used. All intersections shall be securely tied except that where the bar spacing is less than 300 mm in each direction, when only alternate intersection need to be tied.

(v) Binding wire and steel chairs shall not be carried to permanently exposed surfaces and shall be subject to the same requirements with regard to concrete cover as for the reinforcing steel.

(vi) Special care shall be exercised to prevent any disturbances of the reinforcement in concrete that has already been placed. The reinforcement after being placed in position shall be maintained in a clean condition until it is completely embedded in concrete.

(vii) The longitudinal bars shall be straight and fixed parallel to each other and to the sides of the form. The ties, links and stirrups connected to the bars shall be tightly fixed so that the bars are properly braced. The inside of their curved part shall be in actual contact with the bars around which they are fixed and their position shall be exact as shown on the drawings.

Wire for tying reinforcement shall be black annealed iron wire. The diameter of wire shall be adequate and shall have ultimate strength of 5.63 tonnes per sq.cm and yield point of not less than 3.87 tonnes per sqm.

(viii) Reinforcement for lining in special locations, as required, may be fixed in position by means of anchor rods or supporting and hanger rods as approved by the Engineer-in-Charge. In difficult locations, tack welding of bars at isolated spots may be permitted to keep these bars in position provided that diameter of the bars is not reduced adjacent to the weld.

(ix) The steel bars shall be joined by providing lap joints in accordance with the requirements of the relevant Indian Standards or as approved by the Engineer-in-Charge. "Bar-Grip" type joints may also be adopted by the Contractor for deformed bars of 25mm diameter and above, subject to the approval of the Engineer-in-Charge. Splices at points of maximum stress shall however, be avoided. Splices in adjacent bars shall be staggered as directed by the Engineer-in-Charge. Lap length of bars shall be as shown on the drawings. This length may be changed by the Engineer-in-Charge in special locations.

(x) Sufficient concrete coverage as indicated on the drawing shall be provided to protect reinforcement from corrosion. All protruding bars from which other bars are to be attached and which shall be exposed to action of the weather for long period shall be protected from rusting by thin coat of neat cement grout. Accurate record shall be kept at all the times of the number, sizes, lengths and weights of bars placed in position for different parts of the work.

(xi) Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original positions, care shall be taken to ensure that at no time is the radius of the bend less than 4 times of bar diameter for plain mild steel or 6 times of

bar diameter for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

8.7WELDING FOR REINFORCEMENT BARS

(i) Lap splices shall not be used for bars larger than 36 mm diameter, which may be welded with the approval of the Engineer-in-Charge. In case where welding is not practicable, lapping of bars larger than 36 mm may be permitted, in which case, additional spirals shall be provided around the lapped bars. Where welding is approved, the Contractor shall prepare at least three samples of butt welds as directed by the Engineer-in-Charge in recognised laboratory. If the results are satisfactory, the Engineer-in-Charge may allow welding in place of lap joints. The decision of the Engineer-in-Charge in this regard shall be final. The joint shall be butt welded by the electric-arc-method. The ends of the bars shall be cleaned of all loose scale, rust, grease, or other foreign materials and all welding shall conform to the relevant standard specifications for welding or reinforcement bars used in reinforced concrete construction or as directed by the Engineer-in-Charge.

(ii) A weld shall be considered unsatisfactory if it fails to sustain a tensile stress of at least 90% of the tensile strength of the bar in which the weld has been made.

8.8 TOLERANCE FOR PLACING REINFORCING STEEL

Unless otherwise required by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances.

(a) For effective depth of 200mm or less $\pm$ 10mm
(b) For effective depth more than 200mm $\pm$15mm

The cover shall, in no case, be reduced by more than one-third of specified cover or 5 mm whichever is less.

8.9 Tests

The Contractor shall carry out tests

(a) for checking butt welds to replace lapping/ splicing of reinforcing bars.
(b) for to quality of steel reinforcement to be used as per Indian Standards or as directed by the Engineer-in-Charge.

8.10Measurements

Measurement of steel reinforcement placed will be made for making progressive payments against total contract price as per the item rate entered in the Contract document.

9FORMWORK

9.1SCOPE OF WORK

(i) The specifications described hereunder relate to the Formwork. This work shall include all labour, plant and materials and services related to the design, fabrication, supply, erection, maintenance and removal of formwork and false work to be carried out by the contractor under this contract.

(ii) The formwork shall be fabricated and erected to the dimensions of finished surfaces of concrete / masonry as shown on the approved construction drawings or as otherwise directed by the Engineer-in-Charge.

9.2SUBMITTALS

(i) **At least 30 days prior** to the construction of formwork for concrete and other works, the contractor shall submit, to the Engineer-in-Charge, the following:

a) Shop drawings, details and structural computations of the formwork construction.
b) Details of materials, which the contractor intends to use for the fabrication of formwork.

(ii) The Engineer-in-Charge reserves the right to ask for any additional information deemed necessary to be included in the submitted documents.

9.3GENERAL

(i) Forms or formwork shall mean the mould into which concrete / masonry is placed.

(ii) False work or shoring shall mean the structural supports and bracing for forms used in any part of the works.

(iii) All exposed concrete surfaces having slopes of 1.5 : 1 or steeper shall be formed unless otherwise directed.

(iv) Where the character of the natural material cut in, to receive concrete is such that it can be trimmed to the prescribed lines, the use of forms shall not be required.

(v) In this specifications form work / false work has been indicated for concrete work, the same shall apply for other works also like masonry etc.

9.4MATERIALS

(i) Forms shall be of timber, steel or other approved material except that the sheeting for all exposed surfaces, where form lining is not specified, shall be of tongue and groove timber of uniform width unless otherwise directed by the Engineer-in-Charge.

(ii) All materials used in formwork construction shall be of adequate strength and quality for their intended purpose and shall be satisfactory to the Engineer-in-Charge.

(iii) Timber shall be sound, straight, free from warp, decay and loose knots and shall be dressed smooth.

(iv) Where plywood is used, it shall be non-warping, non-wrinkling and manufactured with special water-proof glues. Plywood sheets shall be of uniform width and length.

(v) The surface of steel or steel lined forms shall be smooth. Forms with dents, buckled areas or other surface irregularities shall not be used.

(vi) Reuse of forms and form lumber shall be allowed only if they are cleaned and repaired and capable of producing the finish required for the concrete. Timber or plywood forms repaired with metal patches shall not be used unless permitted by the Engineer-in-Charge.

(vii) Damaged forms or forms which have been deteriorated through usage shall not be used.

(viii) Form oil used on surfaces of timber or plywood forms shall be a straight, paraffin base refined, pale, mineral oil. The oil used on the surface of steel forms shall be specially compounded petroleum oil and other oils of animal or vegetable origin and gums or resins which are heavier in body and frequently darker than straight petroleum oils shall be used in case of steel lining forms. The contractor may use any other material also for coating of the formwork with the approval of the Engineer-in-Charge.

(ix) Forms of like character shall be used for similar exposed surface in order to produce a uniform appearance.

(x) The type, size, shape, quality and strength of all materials from which forms are made shall be the sole responsibility of the contractor but subject to the approval of the Engineer-in-Charge.

(xi) In general, forms for permanently exposed surfaces shall consists of or shall be lined with matched or dressed edge grain timber of appropriate thickness, free from loose or cracked knots.

(xii) Metal forms or metal-lined forms shall be permitted for permanently exposed surfaces only when an entire surface is to be built completely with such forms.

9.5 DESIGN, FABRICATION, ERECTION AND MAINTENANCE OF FORMWORK

(i) Forms and false work shall be designed, fabricated, erected and removed in accordance with the applicable provisions of the Recommended Practice for Concrete formwork of IS:456-1978 and as specified herein.

(ii) All false work shall be designed to withstand safely all live and dead loads, necessary pressures, ramming and vibrations without significant deflection from the prescribed lines, which might be applied to the false work during all stages of construction, service and removal.

(iii) The Contractor shall be solely responsible for the design, construction and maintenance of all formwork and false work required in the work.

(iv) Detailed drawings of shoring and false work shall be prepared by the Contractor. The calculations and drawings shall show the size and specification of the false work, including the type and grade of all materials used in the construction, design loads on false work supports, horizontal forces imposed on the false work and used for design purpose and details of splices and connections including nails, spikes and other

fasteners. If mechanical equipment such as concrete buggies, screening machines etc. are to be used, this information shall be shown on the drawings.

(v) False work shall be constructed only after the false work drawings have been approved by the Engineer-in-Charge.

(vi) The approval of Contractor's drawings by the Engineer-in-Charge shall not relieve the Contractor of his responsibility for the adequacy of form and false work or for the successful completion of the work.

(vii) The Contractor shall construct the false work strictly in accordance with the approved false work drawings, one set of which shall be kept on the site at all times and no changes shall be allowed without prior written acceptance of such changes by the Engineer-in-Charge.

(viii) Forms shall be designed to permit the concrete to be deposited, as nearly as is practicable, directly in its final position and to allow inspection, checking and clean up of the formwork and reinforcement to be completed without delay.

(ix) Formwork and false work shall be designed, constructed, erected and maintained such as to confine the concrete without loss of mortar and produce finished surface which are within the tolerances specified.

(x) Forms for concrete against which backfill is to be placed or which shall not be exposed to view may be constructed of smooth tight boards not less than 25 mm nominal thickness.

(xi) Forms for concrete exposed to flow of water or exposed to view shall be constructed of steel or plywood which is smooth and free from defects with matched and sanded joints to give a symmetrical pattern over the entire area. Chamfer strips (40 mm x 40 mm) shall be used on all exposed concerns, unless otherwise specified or required by the Engineer-in-Charge.

(xii) Forms ties, supports, anchors, braces, spreaders and other similar devices which shall be embedded in the concrete for holding the forms shall incorporate threaded metal bars to facilitate removal of forms. Wood spreaders shall not be left in the forms. Any metal remaining embedded in the concrete shall be at least 50 mm from the surface of concrete. Holes left in the concrete by removal of parts of form ties or similar devices shall be well filled with cement mortar and neatly finished to match the adjacent concrete.

(xiii) Form inserts or similar permanently embedded items shall be accurately located and securely fastened in place. The number and location of form ties and bolts shall be such as to ensure that forms fit tightly against the concrete previously placed and remain in tight contact during operations.

(xiv) Forms shall be set and maintained within the specified tolerance limits such that the complete concrete surfaces are within these limits.

(xv) All form surfaces shall be thoroughly cleaned before erection and shall be lubricated with a non-staining mineral oil. All excess oil shall be wiped off the forms prior to placement of concrete. Oil shall not be allowed to come into contract with reinforcing steel or other embedded items. For use of timber forms, the oil shall be capable of

penetrating the timber and keeping it sufficiently oily to eliminate sticking and preventing absorption of water and consequent warping.

(xvi) The oils shall be applied by brush, spray or swab and the forms shall be covered fully and evenly without excess or drip. Care shall be taken to prevent oil from getting in the surface of construction joints. Special care shall be taken to oil thoroughly the form strips for narrow groove seats, windows, doors and elsewhere so as to prevent swelling of the forms and consequent damage to concrete prior to the removal of forms.

(xvii) Immediately before concrete is placed, all forms shall be inspected to ensure that they are properly placed, sufficiently rigid, clean, tight and properly surface treated and free from encrustations of mortar, grout or other foreign materials. No concrete shall be placed until formwork has been inspected and accepted by the Engineer-in-Charge. Where forms of continuous surfaces are placed in successive units, the forms shall fit tightly over the surface so as to prevent leakage of mortar from the concrete and to maintain accurate alignment of the surface.

(xviii) The formwork for the gate groove areas shall be accurately drilled to be held with first stage anchor couplings/plates to be embedded in primary concrete. Both shall be fixed through formwork into the first anchor couplings/plates to ensure that the coupling/plates remain flush with primary concrete face and the coupling do not get plugged.

(xix) Where timber forms are used, the laying shall be in the direction which will blend architecturally into the lines of the structures as decided by Engineer-in-Charge.

(xx) Curved and special forms shall be such that these will result in smooth concrete surfaces. They shall be designed and constructed so that they will not warp or spring up during erection or placing concrete.

(xxi) When metal sheets are used for lining forms, the sheets shall be placed and maintained on the form with the minimum amount of wrinkles, humps or other imperfections. The use of sheet metal to cover imperfections in the lining of timber faced forms for surfaces that shall be permanently exposed to view shall not be permitted.

(xxii) Where plywood or hardboard is used for form lining, the joints between the sheets shall be smooth and as perfect as practicable and no patching of the plywood or hardboard shall be permitted for permanently exposed surfaces. Minor imperfections in the plywood may be corrected by the use of plastic wood secured firmly in place and sand papered smooth.

(xxiii) Wire ties shall be permitted for the forms when specially approved by the Engineer-in-Charge and shall be cut off flush with the surface of concrete, after the forms are removed. Wire ties shall not be used when permanently exposed finished surfaces are required.

(xxiv) Forms shall be so constructed that the finished concrete surfaces shall be of uniform texture in accordance with the type of finish specified for concrete surfaces in these specifications.

(xxv) The erection of formwork in position shall be rapid enough, rigid and strong to withstand concreting operations and maintain the alignment. Panels of similar shape shall be identical and inter-changeable.

(xxvi) For special section/shapes, timber/steel form shall be used as approved by the Engineer-in-Charge.

(xxvii) The contractor shall strengthen or modify the formwork whenever required by the Engineer-in-Charge.

(xxviii) Unless authorised, suitable mouldings shall be placed to level all exposed edges at construction joints and any other edges shown on the drawings or as required by the Engineer-in-Charge. The final detailed drawings shall show any formed recesses, slots, block outs and similar construction details which have to be taken into account in fixing the formwork.

(xxix) Forms shall be maintained, at all times, in good condition particularly as to size, shape, strength, rigidity, tightness and smoothness of surface.

(xxx) The Engineer-in-Charge will, at any time, have the right to reject formwork which he considers to be no longer fit for use.

9.6REMOVAL OF FORMWORK

(i) Forms shall not be removed until the concrete has hardened and has attained a crushing strength of at least twice the stress which the concrete may be subjected to at the time of removal of forms.

(ii) Duration for which the forms shall remain in place shall be decided by the Engineer-in-Charge, with reference to weather condition, shape, position of the structure or structural members and the nature and magnitude of dead and live loads. The forms shall not be removed without the permission of the Engineer-in-Charge.

(iii) The following minimum intervals of time shall generally be allowed between completion of placing of concrete and removal of forms but the period shall be increased in case of wet or cold weather and also at the option of the Engineer-in-Charge.

Structure	Period in days with normal Portland Cement
(a) Beam sides, walls, columns (unloaded)	3
(b) Slabs and arches (Props left under)	4
(c) Props to slabs and arches	10
(d) Beam soffits (Props left under)	8
(e) Props to beams	21
(f) Mass concrete	2

The above minimum periods are only recommendatory. The Contractor may where he so desires, extend the above to longer intervals. This shall not, however, constitute any reason for any claim for extension of time or damage to concrete etc.

(iv) If the Contractor desires to remove the forms earlier than the period stated above by addition of cement and/or suitable admixtures in the concrete, so as to gain early strength without affecting long term strengths, the matter shall be examined by the Engineer-in-Charge in each case and his decision in the matter shall be final and binding.

(v) Heavy live loads shall not be permitted until after the concrete has reached its design strength.

(vi) The forms shall be removed with great caution and without jarring the structure or throwing heavy forms upon the floor. In order to achieve this end, wedges and clamps shall be used whenever practicable instead of nails.

(vii) In order to avoid excessive stresses in concrete that might result from swelling of the forms, wood forms for wall opening shall be loosened as soon as this can be accomplished without damage to the concrete. Forms for the opening shall be constructed so as to facilitate such loosening.

(viii) The Contractor shall be solely responsible for any damage that may be caused by negligence, lack of proper precautions of hastiness etc. in the matter of removal of forms and shall make the same good to the satisfaction of the Engineer-in-Charge.

9.7Measurement

No separate measurement or payment will be made for any formwork used, as required, at any location of any works and the costs for this is deemed to be included in the contract price.

10 MASONRY

10.1General

10.1.1Scope

The scope of work covered in this section shall comprise all work, the supply of all labour, construction plant and materials of required in connection with the

construction of miscellaneous masonry works for civil structures as shown in the Drawings approved by the Engineer-in-Charge.

It shall also include all appertaining materials and structural parts, scaffolding, transportation, loading, unloading, survey, inspection, test, quality control preparation of foundation surfaces, adjustment of surfaces adjacent to the walls, linings, pavement, etc., and all other operations required to complete the masonry work in all respects.

10.1.2 General Requirements

All materials and structural parts incorporated in the permanent work shall be new and unused. Regarding quality and dimensions they shall comply with these Specifications and approved standards.
All masonry shall be carried out in a workmanlike manner at the highest standard.
All materials to be used for masonry works shall be protected from rain and other deleterious conditions to the satisfaction of the Engineer-in-Charge.

10.1.3 Standards and Codes

All materials and testing shall comply with the standards and codes hereinafter:-

IS1129	Dressing of Stones
IS2250	Sand for Masonry Mortars
IS2116	Specification for Sand
IS3466	Specification for Portland Cement
IS3025	Specification for Water for Concrete Construction

10.1.4 Mortar for Masonry

10.1.4.1 General

The mortar for all masonry works shall consist of cement, admixture for preventing cracks, sand and water. The mortar for masonry work shall be proportioned as given in Table 12.1 . The quantity of water shall be as necessary to obtain a satisfactory workability regarding the use of the mortar.

Proportion of Cement Mortar is given in table below

Particulars	**Cement/Sand Mix Ratio Part by Volume**
Brick masonry work	1 : 4
Stone work	1 : 3

10.1.4.2 **Cement**

The cement shall be ordinary Portland cement complying with the standards specified and all handling shall be in accordance with the provisions set forth.

10.1.4.3 **Sand**

The sand for mortar shall comply with the requirements described in **Section "concrete works"**. The grading of sand shall be as per table 12.2.

Table12.2

Grading of sand

US Standard Sieve Square Mesh No.	Percentage by Weight Passing %
4	100
8	95 – 100
16	70 – 90
30	40 – 75
50	20 - 40
100	5 - 20
200	0 - 10

10.1.4.5 **Water**

Water shall comply with the requirements set forth under **Section "Concrete Works**".

10.1.4.6**Mixing, Transporting and Placing**

The mortar shall be mixed for a minimum of 2 minutes in a mechanically operated drum-type mixer or equivalent mixer approved by the Engineer-in-Charge and the mixer shall be rotated at the speed recommended by the manufacturer. The total quantity of material mixed in each batch shall not exceed the rated capacity of the mixer.

The water shall be added gradually to the mixer, partly before the loading of the dry material and partly immediately after loading. The drum shall be totally emptied before a new batching cycle is started. The drum shall be kept free from hardened mortar and shall be thoroughly cleaned prior to change of mix or on cessation of mixing.

Hand-mixing for small batches may be approved by the Engineer-in-Charge. However, the mortar shall be mixed up to the degree obtained with a mechanically operated mixer. Prior to adding water to the mix, the fine aggregate, cement and admixture shall be mixed dry in a tight box until the mixture has a uniform colour.

The equipment and tools used for transporting and for placing of mortar shall ensure that contamination or loss of ingredients do not take place.Mortar shall be stirred or worked at frequent intervals to prevent separation. All mortar shall be placed within thirty (30) minutes after the water has been added to the batch. Except for necessary tempering on the mortar board, re-tempering of mortar is not permitted.

10.2 Brick work

10.2.1 General

10.2.1.1

All brick works shall be carried out in a workmanlike manner of the highest quality. The masonry shall be performed in horizontal courses true to line and plumb. The arrangement of headers and stretchers within the walls shall be such as to surely bond the masonry and, unless otherwise specified, the masonry shall consist of alternate headers and stretchers with staggered vertical joints in consecutive joints.

Wall ends shall have finished return ends. For masonry permanently exposed to view all bricks shall have sharp, undamaged edges and cutting of bricks to required lengths shall be done carefully. Bed joints shall measure between 8 mm and 15 mm, however, the thickness shall be uniform throughout. Vertical joints shall be 10 mm. All joints of walls to be plastered shall be raked out to a depth of approximately 15 mm. Joints of walls permanently exposed to view shall be raked out to 20 mm while the mortar is still fresh and subsequently neatly pointed at a form instructed by the Engineer-in-Charge.

At corners and intersections of walls the masonry shall be bonded by overlapping blocks at alternate courses. In exceptional cases, the Engineer-in-Charge may permit the use of wire ties thoroughly embedded within the bed joints and anchored in mortar-filled cells. The connection between concrete columns and masonry shall be performed by ties or anchors protruding the concrete. Immediately after completion of a wall or part thereof the wall or part shall be thoroughly cleaned and watered. The wall or part shall be kept wet for at least 3 days.

10.2.1.2 Setting-out

All walls shall be accurately set-out to the dimensions shown in the approved Drawings by suitable equipment and the deviation between the actually set out walls and their theoretical location shall not exceed the below mentioned tolerances, unless otherwise approved by the Engineer-in-Charge. For vertical dimensions of the masonry a site datum shall be fixed at a convenient position to represent the finished ground floor level of the building. The Contractor shall take care when setting-out the first course of a wall and the combination of stretchers, closers and headers shall be laid "dry" for the approval by the Engineer-in-Charge. Repeated dimension controls shall be made at short intervals on all lines, levels and plumb throughout all masonry work.

10.2.1.3 Permissible Tolerances

The dimensional tolerances of masonry in respect of alignments, length, height, thickness, unevenness, etc. shall comply with the following limits:

a. Masonry exposed to view

- all bed joints shall be horizontal and they shall not deviate from a straight, horizontal line by more than 5 mm on a length of 2.50 m;

- the wall surface shall be vertical and it shall at no location deviate by more than 4 mm from the plumb at a length of 2.50 m;

- horizontally the wall surface shall not deviate by more than 4 mm from a straight line on a distance of 2.50 m;

- the deviation of any dimension from the design dimension of walls, openings, recesses, piers, etc., shall not exceed the following values:

Respective Dimension	Maximum Deviation
<1.00 m	4 mm
1.00 m - <2.50 m	5 mm
2.50 m - <10.00 m	8 mm
10.00 m	10 mm

- no abrupt irregularities will be permitted.

b. Masonry to be plastered

- the wall surface shall be vertical and it shall nowhere deviate by more than 6 mm from the plumb at a length of 2.50 m;

- horizontally the wall surface shall not deviate by more than 6 mm from a straight line on a distance of 2.50 m.

- the deviation of any dimension from the design dimension of walls, openings, recesses, piers, etc., shall not exceed the following values:

Respective Dimension	Maximum Deviation
<1.00 m	6 mm
1.00 m - <2.50 m	7 mm
2.50 m - <10.00 m	10 mm
10.00 m	12 mm

- abrupt irregularities shall not exceed 3 mm.

All masonry exceeding the above stated tolerances shall be corrected or replaced by the Contractor.

10.3 Stone Masonry

For the purpose of stone masonry, the Contractor shall stockpile sufficient amount of suitable stones from the rock excavation or from approved quarries.

Stockpiled stone shall be left in air for seasoning preferably for a period of one month prior to placement or as instructed by the Engineer-in-Charge. The moisture of stones shall be kept uniform.

Stone masonry wall shall be of Random Rubble type. Dressing of stone shall conform to IS 1229.

Stonewall shall be sufficiently wetted before laying, to prevent absorption of water from mortar. The bed which is to be received the stone shall be cleaned, wetted and fully covered with mortar. All stones shall be laid in full in wetted surface both in bed and vertical faces and carefully settled in place immediately on placement. Clean Chips and Spalls may be wedged into mortar to avoid thick beds or joints. No dry or hollow space shall be left anywhere in the masonry and stones shall have all its embedded faces completely covered with mortar.

Masonry shall be laid in courses, generally of the same height, where there is a variation in the heights of the courses, longer courses shall be placed at lower levels, with course heights decreasing towards top. Pressure relief sleeves or orifices shall be left in masonry walls as shown on the Drawings or as instructed by the Engineer-in-Charge.

All exposed faces of masonry wall shall be cleared of mortars dropping.

10.3.1 Tests and Properties

All materials applied in masonry work shall comply with the relevant standards regarding quality, dimensions, strength, etc. The Engineer-in-Charge may instruct the Contractor to carry out suitability tests on the material proposed to be applied in the Works as well as to perform quality control tests during the progress of the work as described in the relevant standards.

10.4 Measurement and Payment

Measurement and payment for brick/stone masonry shall be made on the basis of the respective volume in cubic meters of masonry including bonding mortar constructed in accordance with the approved Drawings and Specification for the purpose of making progressive payments on the basis of unit rates entered in the contract against total price of the relevant items.

11DEWATERING AND DRAINAGE

11.1SCOPE OF WORKS

i. The specifications described hereunder relate to the works of dewatering and drainage to be carried out by the Contractor, which shall include supply of all labour, construction plant and material and performance of all services required to remove sludge/ muddy water, service water and natural surface flow or ground water seepage from the Work areas for the construction of various structures covered under the contract.

ii. The works shall be executed in accordance with the Contractor's designs, specifications and sequences as approved by the Engineer-in-Charge.

11.2 SUBMITTALS

(i) **Within 30 days** after the date of issue of the Letter of Acceptance, the Contractor shall submit, to the Engineer-in-Charge, the detailed design of dewatering system.

(ii) This design shall be consistent with the outline description submitted by the Contractor with his bid and shall include the following :

a) Design assumptions and calculations
b) Layouts of drainage / dewatering facilities

(iii) The Engineer-in-Charge reserves the right to require any additional information deemed necessary to be included in the submitted documents.

11.3 GENERAL

The pumped water carried in pipes or channels shall be discharged at point sufficiently away from the edge of foundation excavation as directed by the Engineer-in-Charge. Care shall be taken to ensure that there is no seepage and flow of water back to the pit of the working areas.

11.4 DEWATERING OF SURFACE WATER AT CONSTRUCTION SITES

11.4.1 General

(i) The Contractor shall perform all works necessary to drain out the surface water which happen to be accumulated at work site due to rain, ground water and / or service water. The works shall include, but not be limited to the following :

a) Design and construction of drainage, ditches, pits and pump sumps
b) Design, furnishing, operation and maintenance of dewatering equipment
c) Relocation of dewatering facilities required for the performance of other works, if any.
d) All auxiliary works required for safe and continuous dewatering of the construction sites.

(ii) river/stream Dewatering of construction sites located near a river/stream shall be done upto the existing water level in the river/stream by gravity or otherwise as directed by the Engineer-in-Charge. Suitable drainage shall be made joining the course downstream of the construction site to provide required gradient to facilitate proper and efficient dewatering. Below the water level of the stream, dewatering shall be done by pumping water collected in the sumps and discharging the same into course of the downstream of the construction site.

11.4.2 Requirements and Design

(i) The Contractor shall design and install complete facilities at the surface construction sites.

(ii) The surface water dewatering systems shall be designed to accommodate, without undue disruption to the works, any rainfall event and taking into account the extent of the sites to be dewatered and the dewatering arrangements proposed.

(iii) Claims for extension of time due to delays caused by unfavourable weather conditions will not be considered.

(iv) The Contractor shall provide adequate pumps of suitable capacity, including standby units, to handle all water entering into any of surface construction sites. In addition, he shall provide sumps and pumps and or well points in the immediate vicinity of the structure foundations using such water conductors as are necessary to conduct the water away from the work site as per the requirement of works to be executed in an manner so that such operation shall be kept free from standing or running water.

(v) Power for operating the dewatering system shall be arranged by the Contractor. The Contractor shall make his own arrangements for sufficient standby power at his cost to carry on the works during any interruption of power. The standby power supply shall undergo weekly trial runs lasting at least 30 minutes.

(vi) The Contractor shall ensure that all dewatered / drainage water is disposed off without causing interference on the site and that no drainage water runs into adjacent works.

(vii) The dewatering systems shall be designed and installed in such a way that modifications and extensions to the systems are possible while they are in full operation.

(viii) All the components of the dewatering systems shall be installed and operated in accordance with the approved method and the construction time schedule or approved modification thereof.

(ix) The approval by the Engineer-in-Charge of the dewatering system shall not relieve the Contractor from being fully responsible for the design, construction, operation, maintenance, safety and removal of the facilities provided for the dewatering system and he shall be liable for any damage or delays caused by its failure.

11.4.3Materials and Execution

(i) Drainage ditches shall be excavated along the top of excavated slopes. Such ditches shall be kept well back from excavation edges in order to prevent saturating the upper part of the slopes. The ditches shall be regularly cleaned out of all accumulated silt and other matter so that water may flow freely at all times.

(ii) Where excavation is to be made below the ground water table, the Contractor shall lower the water table sufficiently below any working surface by means of properly screened wells and/or ditches to ensure that the foundation surface remain free of standing water and undamaged by the passage of construction traffic. All ditches shall be outside the foundation areas. The water shall be collected and removed by pumping, if no outflow by gravity is possible.

(iii) Where concrete / masonry is to be placed, the water table shall be maintained below the lowest part of the finished excavation for minimum of one day following the

raising of structure above the natural ground water table and for such additional time as may be necessary to preclude damages to structure foundation.

(iv) In trenches and foundations, the dewatering shall at all times enable to carry out the excavation works in dry.

(v) Upon completion of dewatering, temporary pipes and pump sumps beneath permanent structures shall be closed off and completely filled with grout, mortar or concrete as directed by the Engineer-in-Charge.

11.5 MEASUREMENT AND PAYMENT

No measurement for payment against dewatering and drainage would be recorded as the cost for the same are deemed to be included in the contract price.

12 METAL WORK

12.1 GENERAL

12.1.1 Scope

The work to be performed under this section consists of furnishing and installing the various metal works as necessary in the execution of structures including all the auxiliary works in all structures of the Work as shown on the approved drawings or as directed by the Engineer-in-Charge.

12.1.2 Submissions

At least thirty (30) days prior to commencing the work, the Contractor shall submit to the Engineer-in-Charge the following documents for his approval.

- Detailed shop and construction drawings which shall include complete details, sections and plans of all parts, assemblies, components, connections and supports, and connections to the work of other items.

- Detailed structural analysis of the proposed metal structures, if required.

- Test certificates proving the physical properties stipulated in the Specifications.

Before purchase, samples of all materials proposed for incorporation in the works shall be submitted for approval to the Engineer-in-Charge, as and when required.

12.1.3 Standards and Codes

Unless otherwise specified the materials to be used for the works shall conform to the Indian standards or equivalent International standards with regard to quality, properties and workmanship.

The Contractor shall inform the Engineer-in-Charge of the standards he follows if no particular ones are specified hereinafter. In case the Contractor wishes to follow any other standards and codes, he shall submit sufficient copies of the same to be applied in English to the Engineer-in-Charge for his approval.

12.2 MATERIALS

All materials and structural components to be supplied, erected or installed and, therefore, ultimately incorporated in the structure shall be new and unused. They shall be suitable for their intended purpose and appropriately match each other.

Unless otherwise specified, all materials of metal work shall conform to applicable BIS Codes or the following requirements or equivalent:

- Structural steel : ASTM A6/A6M, A36
- Steel tube and pipe : ASTM A53, A500, A501
- Welding : AWS A5.1, A5.17

In the drawings and the specifications, the size of steel pipes and shaped steel are indicated in the metric system as a rule. The Contractor will be permitted to use those of inch size which are approximately same or more in size as those indicated on the drawings or the specifications.

12.3 Execution

12.3.1 General

(1) Fabrication and Installation

All works shall be executed by skilled workers in a workmanlike manner.

All members shall be cut in such a manner as not to cause deformation or distortion. Irregularity of cut surface shall be properly finished by planer.

The work shall be shop fitted and shop assembled where possible, and shall conform to the details on approved shop drawings to be provided by the Contractor.

Welding shall be made by arc welding unless otherwise directed by the Engineer-in-Charge.

Where necessary, metals shall be insulated to prevent electrolysis due to contact between dissimilar metals and to prevent corrosion due to contact between metals and masonry or concrete. Insulation shall be by means of bituminous paint or other approved means.

All fastenings, anchors and accessories required for fabrication and erection of the work under this section shall be provided by the Contractor. Exposed fastenings shall be kept to an absolute minimum, evenly spaced and neatly set out. Wood plugs shall not be permitted.

Metal work to be embedded in concrete shall be set and fixed in position as shown on the drawings or as directed by the Engineer-in-Charge before placing concrete. If blockouts will be arranged at the locations where embedded parts are set in concrete as shown on the drawings or directed by the Engineer-in-Charge, the metal work shall be fixed in place by the second stage concrete.

The bond surfaces between the first and the second stage concrete shall be roughened. The cross-section dimensions of the second stage concrete and the locations of embedded anchor bolts shall be as shown on the drawings or as directed by the Engineer-in-Charge.

Where it is impracticable to place anchors or anchor bolts when the concrete is placed, holes will be drilled in the hardened concrete 28 days after placing concrete. And expansion bolts, adhesive anchor bolts or other approved anchors will be installed and fixed in place, and then grouted or backfilled with mortar.

(2) Painting and Galvanizing

All components of the metal works shall either be painted or galvanized against corrosion prior to assembly and/or erection. Any preliminary treatment against corrosion shall ensure a basic protection remain effective for at least six months.

All steel surface except galvanized surface and embedded parts in concrete shall be painted. Rust-resistant paint shall be applied in two coats and finishing paint shall be applied in two coats. The quality of paint and the painting works shall be performed in accordance with the provisions in the Specification. The color of paint shall be approved by the Engineer-in-Charge.

Components to be installed to the exterior shall in any case be hot dip galvanized. Galvanizing of steel shall be in accordance with ASTM A123 A153 and A386 or equivalent and the zinc coating shall be not less than 610 g/m.

(3) Auxiliary Works

The following auxiliary works and services shall be deemed to be included in the metal works.

- transport, storing and protection of all structural components on site;
- protection of the executed works from detrimental influences, theft and damages until the time of handover;
- supply of consumable stores;
- removal and making good of all contaminations (building rubbish, refuse and the like) arising from and in connection with the Contractor's works;

12.3.2 Steel Cover

Steel covers shall be installed at openings designated on the approved Drawings or as directed by the Engineer-in-Charge.

Steel covers shall be of steel plate or chequered steel plate, with lifting devices as shown on the drawings or as approved by the Engineer-in-Charge.

Frames shall be composed of shaped steel sections, angles, etc. and shall be anchored to concrete as approved by the Engineer-in-Charge. The frame shall be adjusted during installation to provide an accurate fit with the cover.

In order to ease removal and setting, all covers shall be tapered along the perimeter towards the bottom. The maximum clearance between hatch cover and outer frame shall be 5 mm around at finished floor level.

The corrosion protection shall be generally achieved by painting.

12.3.3 Steel Grating

The steel gratings will serve as covers for gutters, sump and trench, and as tread for step ladder etc.

The steel gratings are normally of a rectangular shape. Some are to be provided with openings for the passage of pipes or ducts as directed by the Engineer-in-Charge or shown on the drawings.

Sizes of steel gratings shall be such as to afford easy handling.

Minimum support width shall be the height of the grating and not less than 30 mm.

The bearing frames of steel angles or channels shall be anchored to the concrete with steel bolts or straps as shown on the drawings or as directed by the Engineer-in-Charge.

Before installation the frame shall be adjusted to allow the steel grating to have a continuous support by the frame.

Before ordering the gratings, the Contractor shall check all relevant locations, dimensions and shapes of the openings.

Steel gratings and frames shall be galvanized. Damaged finishing shall be repaired on site as specified by the manufacturer and to the approval of the Engineer-in-Charge.

12.3.4 Ladder

The Contractor shall supply and install step ladders and steel ladders to the numbers and dimensions as required. Ladders shall be installed where shown in the drawings or where directed by the Engineer-in-Charge. The details of the ladders are referred to the approved drawings or as directed by the Engineer-in-Charge.

Step ladders shall be securely fastened at top and bottom to the wall and shall have intermediate clips and plates be riveted or welded to the side.

All steel members shall be galvanized. All bolts for fastening the ladder to the concrete wall shall be of stainless steel. Where splices are required, bolted connections have to be used.

12.3.5 Steel Stair and Cat Walk

The Contractor shall prepare his own design of steel stairs and cat walks in accordance with the layout and details shown in the approved drawings or as directed by the Engineer-in-Charge.

All landings, stairs and cat walks shall be made of standard steel sections of angle, channel and I-beam shape.

Components or portions thereof shall be pre-assembled with field points designed such as to allow fast and easy erection on site.

Treads of stairs and landings shall be of galvanized steel grating, which have slipless nosing.

The catwalk shall be covered by steel checkered plate.

All outdoor metal parts shall be hot-dip galvanized after manufacture but prior to assembly and no tooling on these parts will be permitted after galvanization.

Of indoor sections only the steel gratings and the chains of railings shall be galvanized; the entire supporting steel structure and railings shall be painted.

12.3.6 Entrance Gate

The Contractor shall design, manufacture, supply and install the entrance gates at the structures to prevent unauthorized persons from entering to the relevant structures as shown in the approved construction drawings or as directed by the Engineer-in-Charge. The gate shall be of a rigid construction. The materials shall be of hot dip galvanized steel sections unless otherwise specified.

12.3.7 Steel Handrail

The Contractor shall position the steel handrails in places as shown on the approved construction drawings or as directed by the Engineer-in-Charge. The Contractor shall be responsible for furnishing of materials, fabrication and installation of the handrails.

Steel handrails shall be fabricated and installed in the places as shown on the drawings. Steel handrails shall be properly anchored to the structures. In general blockouts shall be provided whenever possible and the blockout shall be filled with the concrete after installation.

All parts shall be rust proof painted after manufacturing but prior to installation.

12.3.8Frame for Opening and Cover

a. Frame for opening

Steel angle, z-and/or channel profiles shall be provided for all openings in the size and shape indicated in the approved drawings. These frames shall be embedded in the concrete and attached to the concrete by anchors securely welded to each side of the frame. Anchors may be replaced by anchor plates and stud bolts whenever possible and where shown in the drawings and/or instructed by the Engineer-in-Charge.

All corners of the frames shall be mitered. The surfaces of the frames shall be flush with the concrete surface and the supporting parts, if any, shall be aligned in a way to prevent riding of the covers.

b. Frame for Cover

Concrete covers such as concrete hatch cover and concrete trench cover shall be provided with steel frames as shown in the approved Drawings and/or directed by the Engineer-in-Charge. In general these frames shall be formed by channel profiles, however, the lateral vertical surface shall be slightly inclined to ease lifting of the covers.

All corners of the frame shall be mitered and continuously flush- welded. All welding seams shall be ground smooth. For the connection between the frame and the cover concrete anchors or steel bars shall be welded to the frames.

The frames shall be provided with lifting rings or other arrangements to allow lifting of the covers.

12.3.9 Other Metal Works

Any other metal shall be furnished and installed as shown on the approved drawings or as directed or approved by the Engineer-in-Charge.

12.4 Measurement and Payment

Measurement and payment for metal works shall be made on the basis of the respective items in accordance with the approved Drawings and Specification for the purpose of making progressive payments on the basis of unit rates entered in the contract against total price of the relevant items.

13 STRUCTURAL STEEL

13.1 GENERAL

13.1.1 Scope of Works

This chapter shall include all work in connection with anchor bolts, structural steel works for approach bridge and other miscellaneous works the steel frame of Pumphouse etc., as shown in the approved drawings and as specified hereafter.

The work shall consist of preparation of shop drawings, supply of all materials, fabrication, transportation, storage, erection, painting, inspection, quality control including survey, loading and unloading, protection from damages and other auxiliary works as required.

13.1.2 Submission

The following documents shall be submitted to the Engineer-in-Charge for approval.

(1) Schedule

The Contractor shall **submit a work schedule indicating time schedule** of all works including shop fabrication, transportation, field fabrication, erection at the site and other necessary items related to the work.

(2)Detail Design, Calculation and Shop Drawing

The Contractor shall submit complete shop drawings supported by structural computations, of all structural steel work showing sizes, type and grade of metal, method of assembly, hardware and anchorage or connection with the main structures at least one month before beginning the manufacture of the various items.

Full account shall be made in the design for all temporary loads and stresses which may occur during fabrication, assembly, transportation or erection.

(3)Erection Procedure

The Contractor **shall submit drawings or documents explaining** erection procedure including the temporary bracing method and installation equipment or machinery, at least one month before beginning the erection.

(4)List of Materials

Prior to the procurement of materials, the Contractor shall submit list of materials to be used. The name, official address and brochures showing manufacturing facilities of the manufacturer of materials shall be attached with the list.

(5)Mill Sheet and Certificates of Materials

Mill sheets or certificates of materials which are based on the tests performed in the steel maker or an approved independent laboratory shall be submitted to the Engineer-in-Charge.

13.1.3Standards and Codes

All design, material, execution of work shall comply with the applicable Indian standards and codes or where not covered by these standards to the equivalent International Standards.

13.2 MATERIAL

Except as otherwise specified, all material furnished by the Contractor under this section shall be new, free from defects and imperfections and conform to the BIS or equivalent International Standards.

13.3EXECUTION

13.3.1 Shop Fabrication

(1) Measuring Tape

Measuring tapes for shop fabrication and for erection at site shall be of steel, and deviation of each other shall be measured and informed to the Engineer-in-Charge for approval.

(2) Marking-Off on Material

The positions of bolt hole and shape, dimensions of plate shall be accurately marked on base metal using full size templets.

(3) Cutting and Forming

In cutting base metal, automatic flame-cut method shall be employed. Base metal shall be accurately cut at right angle to the axis and true to marked line and well-formed to size and shape as marked on. Roughness, burrs or any other irregularity of all edges shall be removed using a grinder or a planer.

(4) Bending

Except where inevitable, bending of structural steel shall be done cold. In case that it is necessary to employ a heating process, bending of steel shall be done while the steel is red hot with the approval of the Engineer-in-Charge.

(5) Bolt Hole

Holes shall be drilled with a bit at right angles to the surfaces, and shall not be made or enlarged by burning holes. All bolt holes shall be clean-cut without any burrs or ragged-edges resulting from drilling.

Diameters of holes provided for insertion of bolts shall be as follows:

D	Diameter of bolt hole
More than 20 mm	D + 1.5 mm
Not more than 20 mm	D + 1.0 mm

D: Nominal diameter of bolt

When loose bolt holes are employed, the shape of loose bolt holes shall be shown on the approved drawings.

(6) Welding

a. Welder

Welding shall be executed only by profesional welders who are skillful with welding with all position and experienced in welding of structural steel more than 6 months and approved by the Engineer-in-Charge.

b. Edge preparation and assembling

Edge to be welded shall be made into shape in accordance with the approved edge preparation plan, and shall be free from loose scale, slag, grease, paint or other objectionable materials.

Materials to be welded shall be held firmly by an adequate method so as not to move during the welding works. Tack welding shall be performed in such a manner as to minimize residual internal stress. The Contractor shall take other proper means to prevent strain or residual internal stress from welding.

c. Handling of welding rod

The welding rod shall be stored in their original packing in a dry place, with appropriate protection against the weather. If the welding rod which seem to have suffered the effects of moisture but do not have any other damage can only be used when they have been dried in satisfactory manner.

Welding rod which have areas where the flux covering is broken or damaged shall be rejected.

(7) Permissible Variation

Permissible variation in dimensions of the steel members fabricated at the manufacturer shall be in accordance with the relevant standards stipulated before.

(8) Shop Painting

a. Base preparation and treatment

After the completion of fabrication at shop all of the surface to be painted shall be cleaned of all rust, dirt, oil, slag, scale and any other foreign substance. Cleaning of the surface shall be executed with sandblasting or shotblasting and immediately thereafter wash-primer shall be applied to the surface.

b. Rust-resistant painting

Rust-resistant paint shall be applied in two coats prior to the shipment.

c. Contacting faces for friction grip joint

Contacting faces for friction grip joint of high strength bolt shall be cleaned with sand blasting or shot blasting. Wash-primer, or rust-resistant paint shall not be applied on those faces.

13.3.2 Transportation

The Contractor shall be responsible for all necessary notifications to the concerned office or Authority concerning to the transportation of the member and parts of structural steel. They shall be transported carefully to the site in such a manner as to prevent deformation, corrosion, or other damages.

If necessary, adequate reinforcements, bracing, stiffeners or other means shall be provided.

13.3.3 Storage

The member and parts of structural steel shall be stored under proper covers and placed on supports, so that they are not in contact with the ground or with substances which may cause oxidation and deterioration.

13.3.4 Erection

(1)General

The erection work shall be executed in such a manner that the steel structure do not suffer permanent deformation, and are not subject to stress greater than those considered in the design.

During the erection work the Contractor shall adopt all measures which are necessary to prevent injuries to persons and damage to the neighboring works.

(2)Installation of Anchor Bolts

Anchor bolts shall be installed accurately to meet the positions shown on the approved drawings and the positions of anchor bolts shall be inspected before placing of concrete. When placing concrete, care shall be taken so as not to move the position of anchor bolts.

(3)Friction Grip Joint

a.Length of high strength bolt

Standard length of stem shall be obtained by adding respective length tabulated below to the grip thickness.

D (mm)	L (mm)
16	30
20	35
22	40
24	45

Where,
D:Nominal diameter of bolt
L:Length to be added to grip thickness

The bolt set shall be stored in their original packing, and care shall be taken so that materials would be free from dirt, damage and corrosion.

b.Treatment of contacting surfaces

The surfaces to become in contact with surface of another steel plate in friction grip joint shall be free from paint, oil and other defects that would decrease friction force.

c.Tightening

Temporary tightening shall be performed using bolts not less than one third (1/3) of the total number of bolts in each completed joint but never less than two. Bolts for temporary tightening shall be distributed uniformly about the joint.

Tightening shall be done using either the impact wrench method or the "turn-off-nut" method in accordance with the instruction of the bolt manufacturer. The work shall be done by competent and experienced bolting crews.

70 percent of design bolt tension shall be given to the bolts at preliminary tightening and then 100 percent of design bolt tension shall be given to the bolt finally.

Excessive tightening of the bolts shall not be permitted.

d.Calibration of impact wrench

If the bolts are tightened by impact wrench method, each impact wrench shall be calibrated prior to the commencement of the work each in the morning and the afternoon.

The impact wrenches shall be equipped with torque indicating scale or calibrating means so that the torque can be measured clearly.

(4) Erection

All steel members shall be installed accurately to meet the positions and level shown on the approved drawings and the positions and level shall be inspected before permanent fixing.

During the erection works, the steel structure shall be ensured sufficiently to withstand all loads such as its own weight, live loads, wind loads and erection loads. All temporary bracing, guys and bolts necessary to ensure safety of the structure shall be provided.

(5)Permissible Variation

Permissible variation shall be in accordance with the relevant Indian standards.

13.3.5 Field Retouch Painting

After installation, all damaged shop coated areas and all bolting, welded and other surfaces left un-painted with rust-resistant paint shall be cleaned of all rust, dirt and any other foreign substances and shall be painted with rust-resistant paint.

13.3.6 Inspection

(1)General

All materials supplied and all work performed shall be subject to inspection by the Engineer-in-Charge at the place of manufacture, fabrication and/or erection. Unless inspection is waived by the Engineer-in-Charge, no material shall be shipped until after such inspection and acceptance of the material has been performed.

Where directed by the Engineer-in-Charge, certified mill or shop-test reports shall be furnished in lieu of inspection at the mill. Acceptance of material or waiving of inspection thereof shall in no way relieve the Contractor of the responsibility of furnishing the materials and workmanship conforming with the Specifications in all respects.

The Contractor shall submit the records of tests stating the name of test, time and place, results and name of inspector.

The judgement of results of test and inspections shall be made according to the applicable provisions of the standards stipulated before.

Tests or inspections may be waived with the approval of the Engineer-in-Charge in case mill sheets or certificates or other appropriate evidences are submitted by the Contractor.

(2)Material Test

Quality of the principal materials to be used, such as rolled steels, bolt and nuts, electrodes shall be tested.

(3) Qualification Test for Welding Operators, Welders and Welding Procedures:

Shall be performed in accordance with the applicable standards.

(4)Inspection of Edge Preparation

Shall be performed in accordance with the approved plan of edge preparation.

(5)Appearance and Measurement Inspection

The appearance inspection shall be made on welded joints, bolts holes to be bolted in the field, coated surfaces and on other items for defects.

(6)Inspection of Welded Joint

Welded joint shall be inspected by means of radiographic (X-ray) method and/or ultrasonic method.

The rate of spot inspection shall be not less than 10% of the total welded length.

13.3.7 Quality Control

The Engineer-in-Charge reserves the right to ask for independent analysis and tests on the materials by an analyst or testing laboratory selected by him, in order to check the works, analysis and tests. For this purpose the Engineer-in-Charge may take samples for analysis and have pieces cut out side by side with pieces subjected to test in the workshops. Should the comparison of the result of any independent analysis or test be unsatisfactory, the materials represented will be rejected. All incidental cost for the above shall be borne by the Contractor.

13.3.8 Auxiliary Work

Mortar grouting at the base plate, installation of embedded steel parts in concrete structure shall be included in the work. Shuttering needed for these works shall also be included in the work.

13.4MEASUREMENT

Measurement of structural steel shall be based on weight by metric ton. All materials including bolts, deck plates and other steel parts shall be measured. Measurements will be made for making the progressive payments against the total contract price for the work, on the basis of rates entered in the schedule of works

14FINISHING AND MISCLLENEOUS ITEMS

14.1 SCOPE OF WORK

This section covers specifications for miscellaneous item like providing and fixing aluminum windows/doors with glazing, rolling shutters, terrazzo tiles, vinyl asbestos tiles, improved flooring, CC flooring, M.S. grating, steel work in single section in cable duct, RCC jali, W.C. Pan, wash basin, urinal unit and aluminum pipe railings, joints and water proofing treatment in intake and pump house building, pipes, installation of embedded parts, shotcreting, brickwork, coursed rubble masonry, sausage wall, approach road, and drainage arrangement etc. The work shall include all labours, materials, equipment tools and tackles etc. required for completion of the works.

14.1.1 Application Publications

All methods and procedures shall conform to Indian Standard Specification some of which are listed below :

IS:816	**Welding**
IS:1038	Specification for steel doors and windows
IS:1081	Glazing
IS :1239	Mild steel tubes
IS:1761	Glazing
IS:3548	Glazing
IS:4351	Door Frames
IS:269	Portland Cement
IS:800	Structural Steel
IS:814	Welding Electrodes
IS:2556 (Part. II)	Water Closet
IS:2556 (Part. IV)	Wash Basin

IS:2556 (Part. VI)	Urinals
IS:774	Flushing System for W.C.
IS:781	Copper alloy bib taps
IS:775	Cast iron brackets
IS:1948	Specification for aluminum doors windows and ventilation
IS:1949	Aluminum Windows for industries building

14.2 ALUMINIUM DOORS, WINDOWS AND VENTILATORS

14.2.1General

The contractor shall submit shop drawings details of various parts, methods of anchoring and any other pertinent details for the approval of the Engineer-in-charge. Before placing orders the contractor shall submit sample of hardware to the Engineer-in-charge for approval.

14.2.2 Materials

a) Aluminum alloy used in the manufacture of extruded window sections shall correspond to IS designations HEO 9-WP of latest edition of IS : 733. Hollow aluminum alloy sections used shall conform to IS Designation HV9-WP of latest edition of IS : 1285. Dimensions and weight per metre run of the extruded sections shall conform to latest edition of IS : 1948 and IS : 1949.

b) Coupling sections – Aluminum alloy coupling sections used shall conform to IS Designation HV9-WP of latest edition of IS : 1285.

c) Glass panes – Glass panes shall weigh atleast 7.5 kg/cm^2 and shall be free from flaws, specks or buggles. All panes shall have properly squared corners and straight edges. The sizes of glass shall conform latest edition of IS : 1948.

d) Screw threads of machine screws used in the manufacture of aluminium doors and windows and ventilators shall conform to the requirements of latest edition of IS : 1362.

e) The metal thickness shall not be less than 1.6 mm for frame and 2.3mm for threshold.

14.2.3 Fabrication

Frames shall be square and flat, the corner of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections which have been cut to length, metred and welded at the corners. Where hollow sections are used with welded joints, argon arc welding or flash butt welding shall be employed (gas welding or brazing not to be done). Subdividing bars of units shall be tenoned are riveted into the frame.All fabrication shall conform to latest edition of IS 1948, 1949 and other relevant IS wherever available. Generally side hung shutters shall be used for door and windows.

Top-hung shutters shall be used for ventilators. And Central hung shutters shall be used for doors also. For fixing aluminum alloy hinges, slot shall be cut in the fixed frame and the hinges inserted inside and may be riveted to the frame. Cast or extruded aluminum alloy hinges for doors shall conform to latest edition of IS :1949, IS :617 and IS :733. The hinge shall be of projecting type. Non projecting type of hinges may also be used. The handle for doors and windows shall conform to latest edition of IS 617 and other relevant Indian Standards wherever applicable. Suitable lock for door operable either from inside or outside shall be provided. Any steel lugs coming in contact with aluminum should be either galvanized or given one coat of bituminous paint.

14.2.4 Finish

Aluminum doors, windows and ventilators shall be supplied & be anodized. Colour anodizing to be done using approved light fast shades.
A thick layer of clear transparent lacquer based on methacrylates shall be applied to protect the surface from wet cement during installation and after installation the lacquer coating shall be removed.

14.2.5 Glazing

Glazing shall be provided on the outside of the frames.

14.2.6 Hardware

Hardware for the Aluminum doors, windows and ventilators shall comply with the requirements specified on the drawings. The contractor shall submit catalogues and samples to the Engineer-in-charge for approval prior to supplying hardware. The hardware shall comply with the following requirement :

Hinges	Conforming to latest edition of IS :1948, IS :617, IS :753, IS :1949.
Knobs	Aluminum approved quality.
Lock sets	Aluminum cylinder lock of approved make.
Flush bolts	Wall or floor mounted type with rubber bumper and holder.
Door stops	Wall or floor mounted type with rubber bumper and holder
Door closers	As per relevant IS code
Hand plates	Aluminum approved make as per IS code
Hand Balls	Aluminum approved make as per IS code

The contractor shall supply three keys for each lock fitted.

14.2.7 Glazing

14.2.7.1 Materials

Glass for glazing of windows and doors shall be sound free from specks, waves and flows and shall be conforming to latest edition of IS : 1761, IS : 1081 and IS : 3548.

14.2.7.2 Execution

Glass shall be accurately cut to size to suit the dimension of openings. Glazing to Aluminum doors, windows and ventilators shall be carried out by means as described in IS code wherever available. Glass shall be cleaned and polished on completion of building works.

14.3 STEEL ROLLING SHUTTER DOOR

Steel Rolling Shutter doors capable of both electric and manual operation shall be installed at the location shown in the approved drawings and in accordance to the relevant IS Specifications. All steel plate and angles, welding and bolting shall conform to the specifications provided in section-7. The doors shall be composed of a shutter, guide rails, rolling drum and cover case, with a motor control gear, safety switch, wiring and all other accessories.

The various components shall be as follows :

Guide rails: 2.3 mm thick roll-formed steel plates, depth 75 mm, with safety stop at a height 2.2 mm above the floor.

Cover Case: 1.6 mm thick steel plate with adequate reinforcement and inspection hole.

Motor : Electric Source A.C. 230 Volt, 3 Phase 50 Hz. Operation speed 3 to 5 m/min. Motor to be installed in the cover case, operation box to be installed in the side wall at adequate height and provided with both electric and manual operation devices with all necessary accessories including hand plate and hand bar of stainless steel. The manual operation device shall be suitably geared to allow operation by one man.

14.3.2 Measurement

Measurement for providing, fabricating and fixing for Aluminum windows, doors with glazing and steel rolling shutters shall be measured on the basic of square metre.

14.4 FINISHES FOR WALLS, CEILING AND FLOORS

14.4.1Cement Plaster

The walls and the ceilings of the intake structure and the pumphouse shall be finished smooth with cement plaster as specified below:

	Particulars	Thickness of plaster	Proportion
1.	Wall	15 mm	1 cement : 4 sand
2.	Ceiling	6 mm	1 cement : 3 sand

14.4.2 Materials

i. Cement mortar shall consist of cement and sand and shall conform to the following.

1. Cement shall be ordinary Portland cement type in accordance with latest editions of IS : 269. The supply, use, storage and testing of cement shall be in accordance with IS specification.

2. Sand shall be clean, hard and durable, of proper grading and free from dirt, organic or deleterious materials.

The grading of the sand shall be within the following limits:

Classification	Screen Designation	Percentage by weight Passing screen
Rendering Coat	5 mm	100%
	0.15 mm	10% or under
Finishing Coat	2.5 mm	100%
	0.15 mm	10% or under

ii. The quality of the mortar. If required by the Engineer-in-charge water shall be tested Water used in the mixing of mortar shall be fresh, clean water suitable for drinking. Water shall not contain salt, oil, alkali, organic matter or other deleterious substances which would impair.

iii. Waterproofing and colored admixture shall be used in the cement mortar in strict accordance with the manufacturers printed instructions.

iv. The mix proportions of the cement mortar shall be as specified in the bill of quantity of this work. Water proofing compound @ 5% by weight of cement (maximum) shall be used in strict direction of the Engineer-in-charge.

Rate of respective items of work shall include cost of admixture etc.

v. The pigment of the coloured cement mortar shall be of good quality and approved by the Engineer-in-charge. It shall be used in accordance with the manufacturer's instructions.

14.4.2.1Preparation of Surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned of and care shall be taken that none of the retarders is left on the surface.

14.4.3 Mortar

The mortar of the specified mix using the type of sand described in the item shall be used. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

14.4.4 Application of Plaster

Ceiling plaster shall be completed before commencement of wall plaster.Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied horizontally and vertically at not more than 2 metre intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be beaten with thin strips of bamboo about one metre long to ensure thorough filling of the joints, and then brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and side ways movements at a time. Finally the surface shall be finished off with trowel or wooden float accordingly, as a smooth or a sandy granular texture, as required. Excessive trowelling or of working the float shall be avoided. During this process, a solution of lime putty shall be applied on the surface to make the later workable.

All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, rises, junctions etc. where required shall be done without any extra payment. Such rounding or chamfering shall be carried out with proper templates to the sizes required.

In suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically, when recommencing the plastering the edge of the old work shall be scraped and wetted with lime putty before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of the feature such as plasters, bands cornices, nor at the corners or rises. Horizontal joints in plaster work shall not also occur on parapet tops and copings, as these invariably lead to leakage. No portion of the surface shall be left out initially to be patched up later on.

a) Beating with thin bamboo strips shall not be done on the cement plaster and

b) No lime putty solution shall be applied on the face when finishing. Further the plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

14.4.5 Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of not less than 7 days. During this period, it shall be suitably protected from all damages at the contractor’s expense by such means as the Engineer-in-charge may approve. The dates on which the plastering is done shall be legibly marked on the various section plastered so that curing for the specified period there after can be watched.

14.4.6 Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

14.4.7 Measurements for Payment

Length and breadth shall be measured for payment correct to a cm and its area shall be calculated in square metres correct to two places of decimals.

Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick works.

The measurements of wall plaster shall be taken between the walls or partitions (the dimensions before plastering shall be taken) for the length, and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any be deducted.

Deductions in measurement, for openings, etc. will be regulated as follows :-

a) No deduction will be made for openings or ends of joints, beams, posts, girders, steps etc. upto 0.5 sq m in area, no additions shall be made either, for the jambs, soffits and sills of such openings. The above procedure will apply to both faces of wall.

b) Deduction for openings exceeding 0.50 sq. m but not exceeding 3 sq. m each shall be made for reveals, jambs, soffits, sills etc. of these openings.

i. When both face of walls are plastered with different types of plaster or if one face is plastered and other is pointed, or one face is plastered and other is unplastered, deductions shall be made from the plaster or pointing on the side of the frame for the doors, windows, etc. on which width of reveal is less than on the other side but no deductions shall be made on the other side.

ii. Where width of reveals on both faces faces of are equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be

iii. For opening having door frame equal to or projecti.ng beyond thickness of wall, full deduction for opening shall be made form each plastered face of wall.

14.5 NEAT CEMENT PUNNING

Specifications for this item of work shall be same as described in clause 17.4 except for the additional floating coat of neat cement to be carried out as below :

When the plaster has been brought to a true surface with the wooden straight edge it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for a floating coat shall be 1 kg sq. m smooth finishing and shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in 17.4.4 shall apply.

14.6 NISHES OF FLOOR

14.6.1 Resilient Tiles

Resilient tile and skirting shall be approximately 250 mm x 250 mm x 3 mm and 100 mm x 100 mm x 3 mm, respectively. Colour and patterns shall be selected by the Engineer-in-charge from the standard range.

The tiles shall be set on a thoroughly dried rendered base.

The layout shall be subject to the approval of the Engineer-in-charge.

Tile and skirting shall be adequately protected during the time of setting for a subsequent period. No traffic shall be allowed on the tiles for 48 hours after setting

14.6.2 Pre-cast Terrazzo Tiles

Pre-cast terrazzo floor tiles shall be made from portland cement and coloured stone chipping and shall be pressure moulded and ground to size. The tiles shall be hard, durable and sharp, true edges. Colours and patterns and patterns shall be selected by the Engineer-in-charge from a standard range.

The size of tile shall be as follows :

Floor tiles : 300 mm x 300 mm x 20 mm thick

Floor skirting 100 mm and 200 mm high.

Tiles and skirting shall be bedded and pointed in 1:3 cement mortar. Bedding for tiles shall be of required thickness to suit finished floor levels.

14.6.3 **Ceramic Glazed Wall Tiles (Internal)**

The ceramic will tiles for interior use shall be made of porcelain or earthenware. Tiles shall be 100mm square x 6 mm thick. Tiles shall be hard, durable and non-absorbent of exact shape and even thickness and shall have cushioned edges. Coloured and patterns shall be selected by the Engineer-in-charge from a standard range. Tiles shall be bedded in adhesive supplied by the tile manufacturers and pointed with white cement.

14.7 FALSE CEILING

14.7.1 The entire area to be air conditioned shall be provided with false ceiling of hard board three layer flat pressed teak timber tile each of size 60 cm x 60 cm x 12 mm thick or other approved suitable material for the false ceiling and the supporting frame material which shall be supplied & installed by the contractor. The complete material for the false ceiling and the supporting frame work shall be supplied by the contractor & shall conform to the relevant Indian Standards. After installation, the false ceiling (face towards the floor of the air condition rooms), shall be given suitable coating for protection as well as better finish. The colour of the coating shall be as approved by the Engineer-in-charge. Detailed embedment drawing showing details of necessary embedments (Aluminum) to be provided in the ceiling for supporting the false ceiling frame work and ducts etc. shall be furnished by the bidder alongwith their offer. A suitable arrangement properly utilising these plates shall be furnished for approval of the Employer. All supporting material shall be supplied by the contractor.

14.7.2 Specification

Suitable provision such as semi-transparent panels or louvered openings etc., for illumination of the room shall be made in the design of the false ceiling. Full information regarding the proposed fittings for illumination purposes shall be furnished by the Contractor to the Employer. Supply and installation of lighting equipment shall be the responsibility of Contractor.

14.7.3 False ceiling supporting frame work including the Aluminum plates shall be given suitable rust resistant coating after proper cleaning of the surfaces.

14.7.4 The supporting arrangement shall be so designed as to permit easy dismantling etc. for maintenance of air conditioning equipment's or light fittings, etc.

14.8 PAINTING

14.8.1 Materials

Paints, oils, varnishes, etc., of approved brand and manufacture shall be used. Paints shall be synthetic enamel ready mixed paints and shall be used as received from the manufacturer. 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 Engineer-in-charge shall be used.

Approved paints, oils, or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition.

14.8.2 Execution

Painting shall not be started until the Engineer-in-charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other builder's work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least on day in advance of the paint work being started.

14.8.2.1 Preparation of Surface

The surface shall be thoroughly cleaned and free from dust. All rust, dirt, scales, smoke and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-charge after inspection, before painting is commenced.

14.8.2.1.1 Application

Painting/Varnishes of approved colour and quality shall be done two coats over a priming coat over steel/wood works

Before pouring into smaller containers for use, paint shall be stirred thoroughly in its containers, when applying also, the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grain of wood. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying-off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of mouldings, etc shall be left on the work.

In painting doors and windows, the putty round the glass panes must also be painted; but care must be taken to see that no paint stains etc., left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting.

In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

14.8.2.2 Brushes and containers

After work, the brushes shall be completely cleaned of paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that paint does not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

14.8.2.2.1 Measurements

The length and breadth shall be measured for payment to a cm. The area shall be calculated in sq. metres (correct to two places of decimal), except otherwise stated.

Small articles not exceeding 10 sq. decimetre (0.1 sq. m) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

Painting up to 15 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres.

Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sq. metres irrespective of the size or girth of members.

In measuring painting, varnishing, oiling etc., of joinery and steel work etc. the coefficients as in following tables shall be used to obtain the area payable.

The following coefficients shall be applied to the areas measured flat and not girthed.

Table 1 Equivalent Plain Areas of Uneven Surfaces

Sl. No.	**Description of work**	**How measured**	**Multi plying co-efficient**
1	**2**	**3**	**4**
a)	Panelled or framed and braced doors, windows etc. .	Measured flat (not girthed) including Chowkhat or frame Edges, chocks, Cleats,etc. shall be deemed to be included in the item.	1.30 (for each side)
b)	Ledged and battened or ledged, battened		

	and braced, doors, windows etc.		
c)	Flush doors etc.	. DO	1.20 (for each side)
d)	Rolling shutters of interlocked laths	Measured flat (size of opening) all over jamp guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)
e)	Fully glazed or gauged steel doors windows	Measured flat (not girthed) including frame edges etc.	0.50 for each side)
f)	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard Bars, balustrades, Railings, partitions And M. S. Bars in Windows frames	Measured flat overall ; no deduction shall be made for open spaces; supporting members shall not be measured separately	1 (for paint all over)
g)	Open palisade fencing and gates including standards, braces; rails stays etc,. in timber or steel	------Do---------	1 (for paint all over)

Explanatory notes for table 1

1. Measurement for doors windows etc. shall be taken flat (and not girthed) over all including chowkhats or frames, where provided. Where Chowkhats or frames are not provided, the shutter measurements shall be taken.

2. Where doors, windows, etc., are of composite types other than those included in Table 1 the different portion shall be measured separately with their appropriate coefficients, the center line of the common rail being taken as the dividing line between the two portions.

3. The coefficients for doors and windows shall apply irrespective of the size of frames and shutter members.

4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.

5. When the two faces of a door, windows etc., are to be treated with different specified finished, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

6. In the case where shutters are fixed on both faces of the frames. The measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter area only excluding the frame.

7. Where shutters are provided with clearance at top or/ and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficients shall be applied to obtain the area payable.

8. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

9. The measurements of guard bars expanded metal, hard drawn steel wire fabric of approved quality grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

14.8.2.2.2 For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail,. if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades. Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

14.8.2.2.3 Precautions

All furniture's, fixtures, glazing, floors, etc., shall be protected by covering and stains, smears, splashings, if any shall be removed and any damage done shall be made good by the contractor at his cost.

14.8.4 Painting priming coat on wood, iron or plastered surfaces.

14.8.4.1 Primer

The primer for wood work, iron work or plastered surface shall be as specified in the description of the item.

Primers for plaster/ wood work/iron & steel/ aluminum surfaces shall be as specified below :

TABLE - 2

	Surfaces	Primer to be used
1.	Wood work (hard & soft wood)	Pink conforming to latest edition of IS 3536)
2.	Resinous wood and plywood	Aluminum Primer
	Aluminum steel and galvanised	Zinc chromate primer

	Steel work	conforming to latest edition of IS : 104
4.	Cement brick work, plaster surface, asbestos surface for oil bound distemper and paint	Cement Primer

The primer shall be ready mixed of approved brand and manufacture.

14.8.4.2 Preparation of Surface

14.8.4.2.1 Wooden Surface

The wood work to be painted shall be dry and free from moisture.
The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used for. Appropriate filler material with same shade as paint shall be used where specified.

14.8.4.2.2 Iron & Steel Surface

All rust and scales shall be removed by scraping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.
All dust and dirt shall be thoroughly wiped away from the surface.
If the surface is wet, it shall be dried before priming coat is undertaken.

14.8.4.2.3 Plaster Surface

The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of Paris and rubbed smooth.

14.9 DRY DISTEMPER

14.9.1 Materials

Dry distemper of required colour and (IS-427) of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer-in-charge before application of distemper. The dry distemper colour as required shall be stirred slowly in clean water using 6 decilitres (0.6 litre) of water per kg of distemper or as specified by the manufacturer. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use.

14.9.2 Application

i. Before application of distemper is taken up, the surface shall be thoroughly brushed free from mortar dropping, other foreign matter and sand and prepared smooth. New plaster surface shall be allowed to dry for at least two months before applying distemper.

ii. After preparation of the surface A priming coat of whiting shall be applied over the prepared surface. No white washing coat shall be used as a priming coat for distemper. The treated surface shall be allowed to dry before distemper coat is given.

iii. Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and stirred to form a thin slurry and two kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum of slurry. The mixed slurry shall then be diluted with water to the consistency of milk so as to make a wash ready for use.

iv. Distemper shall be applied two or more coats over the dried surface of the primary coat till the surface shows an even colour. The entire surface shall be coated with mixture uniformly, with proper distemper brushes in horizontal strokes followed immediately by vertical ones which together shall constitute one coat. The subsequent coat shall be applied only after the previous coat has dried. The finished surface shall be even and uniform and shall show no brush mark.

14.10 PROVIDING AND FIXING ANODIZED ALUMINIUM PIPE RAILING 40 MM DIAMETER

14.10.1 General

Anodized aluminum pipe railing shall be provided as shown on the drawing or as directed by the Engineer-in-charge. The railing shall be made of 3 rows of 40 mm diameter anodized aluminum pipes conforming to IS fixed in position one above the other as shown on the drawings in 1.2 metre height with vertical supports of 100 x 50 x 5 mm J section, 1.5 meter center to center. In the construction drawing suitable adjustment in the pattern as indicated above and as required as per actual site condition and as directed by the Engineer-in-charge shall have to be carried out by the contractor. All railing shall be so constructed as to enable removal of the parts for repair and replacement.

14.11 PIPES

14.11.1 General

The work to be done under these specifications include providing and installing mild steel black perforated pipes, G.I. pipes required for water supply system connecting drainage holes to the gallery, and internal drainage of intake and pump house building, vertical drainage pipe, rigid un-plasticized PVC pipes for potable water supplies.

14.11.2 Application Publications

All methods and procedures for installing and testing of pipes shall conform to latest edition of Indian Standard Specification listed below, unless otherwise specified.

Indian Standards:

1.	**IS:2026**	**Specification for Structural Steel (Standard Quality)**
2.	IS:554	Dimension for Pipe Thread where Pressure Tight Joints are Required in Threads.

3. i)	IS:1239 (Part – I)	Specification for Mild Steel Tubes, Tubulars and other Wrought Steel Fittings.
ii)	IS :1239 (Part – II)	Mild steel Tubulars and other wrought steel pipe fittings.
4.	IS:3589	Specification for Electrically Welded Steel Pipes of Water and Sewage.
5.	IS:4711	Methods of Sampling of Steel Pipes, Tubes and Fittings.
6.	IS:4984	Specification for high Density polythylene pipes for potable water supply.

14.11.3 Rigid (Unplasticized) PVC Pipes

14.11.3.1 The pipes shall be reasonably round and shall be supplied in straight lengths with socketed end. The internal and external surface of pipes shall be smooth and clean, free from grooving and other defects. The pipe shall be designated by external diameter and shall conform to latest edition of IS 4985.

14.11.3.2 Fittings :- Fittings used shall be of the same make as that of PVC pipes, injection moulded or made in cast iron and shall conform to relevant Indian Standard.

14.11.3 JOINTING

17.11.3.1 G. I. Pipes

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, tee etc., with the pipe wrench also as not to damage the pipe care shall also be taken that all pipes and fittings are properly jointed so as to made the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing.

14.11.3.2 PVC Pipes

Solvent cement joints/ flanged joint/rubber ring joints shall be provided and shall conform to relevant Indian Standards.

14.11.3.3 Cast Iron Detachable Joints

The joints shall consist of a central collar, two rubber rings two flanges of cast iron and the required number of bolts and nuts. One flange and rubber ring shall be placed one end of the pipe already laid and the other flange, rings and central collar shall be slipped on the pipe to be assembled. The rubber ring shall be kept positioned at half the collar width less 2.5 mm from the end of the pipe already laid. A site gauge may be used for convenience. The other pipe shall be brought nearer leaving a gap of 5 mm between the two pipe ends. This gap will facilitate maneuvering of deflection at joints after assembly and will take care of an expansion in the pipe line. The collar shall be slided to sit square around the rubber ring on pipe to sit around collar. The flange shall be moved on both ends to enclose rubber rings. The fastenings bolts shall be inserted through the holes of the flanges and the bolts shall be tightened alternately and evenly for proper sitting of the joint.

14.11.3.3 Cast iron fittings and accessories

Cast iron fittings are jointed by cast iron detachable joints only. Cast iron specials having flanges jointed in the pipe with the cast iron flange adapters having one end flanged and the other plain ended. When there will be tendency for the pipe ends or specials ends to slipout of the joints anchorage shall be provided against the direction of thrust.

14.12 WATER SUPPLY, SANITARY AND DRAINAGE FITTINGS

14.12.1 PROVIDING AND FIXING WATER CLOSET

White vitreous china water closet squatting pan (Indian type) shall be provided and shall conform to latest edition of IS : 2556 Pt.II. The pan shall have following accessories :

a) 'P' or 'S' trap
b) Foot rest pair in white vitreous china (size 25 x 13 x 3 cm.)
c) Low level flushing cistern of 12.5 litre capacity of white vitreous china including 15 mm dia inlet, float valve, C.P. brass heavy stop cock and handle etc.

The squatting pan shall be fitted flush with floor level. Brick lime coba shall be filled under the pan after fixing it to the correct position.

In fixing the pan if holes are made in the floors or wall the same should be repaired with 1:3 cement mortar, complete.

Flushing cistern to the wall shall be with CI bracket and repair of wall with 1:3 cement mortar.

14.12.3 Providing and Fixing in Position White Vitreous Flat Back Lipped Urinal

White vitreous flat back lipped urinals shall conform to IS : 2556 (Pt. IV). The urinal unit shall have following fittings and accessories.

a) Flushing cistern of 5 litre capacity – conforming to IS : 774 with flush pipe for back and front flush with spreader pipes with fittings.
b) Standard urinal C.I. trap 65 mm dia with vent arm and outer gratings and coupling in C.P. brass trap and unions.
c) White vitreous china tiling upto 1200 mm height on front and side walls.

The urinal shall be fitted on C.I. bracket embedded in wall. In fixing the urinal if wall is damaged the same shall be made good by repair. All fittings and C.I. bracket shall be painted with ready mixed paint of approved quality.

Payment for the item shall be made on the basis of numbers of urinal units fixed in position.

14.12.4 Providing and Fixing Wash Basin

White vitreous china wash basin shall conform to IS : 256 (Pt. IV). The wash basin of size 55 x 40 cm size shall have following accessories.

a) Rolled Steel or Cast Iron conforming to IS :775 duly painted
b) 15 mm dia C.P. brass pillar taps and C.P. brass chain rubber plug.
c) 32 mm dia brass waste coupling
d) 15 mm dia lead inlet connection of minimum 40 cm in length
e) 15 mm dia brass heavy duty stop cock
f) 32 mm C.I. trap and brass cleaning thimble upto and outside wall till gully trap
g) C.I. clips, 40 mm dia G.I. pipe sleeve.

The wash basin shall be fixed on C.I. bracket embedded in wall. In fixing the wash basin if holes are made in floor or walls the same should be repaired with 1:3 cement mortar to the original condition. All fittings and C.I. bracket shall be painted with ready mixed paint of approved quality.

14.13 MS GRATING AND STEEL WORK IN SINGLE SECTION (CABLE DUCT)

14.13.1Description

400 mm wide M. S. grating over drain is consisting of 25 x 3 mm MS flats 50 mm c/c both ways welded to IS Angles of size 30 x 30 x 5 mm. All structural steel used for grating shall conform to latest edition of IS : 226. The welding shall conform to latest edition of IS : 816.

14.13.1.1 Steel work in single section for cable duct consists of 9 rows of angles 50 x 50 x 5 mm on both sides fixed in R.C.C. wall.

14.14 R.C.C. PRECAST COVER

The specification for providing and fixing RCC pre-cast cover of size 750 x 750 x 300 mm over drain shall conform to Section-5 concrete and reinforcement of this specifications.

14.15 JOINTS AND SEALS

14.15.1 Scope of Work

14.15.1.1

The section covers specifications for providing Polyvinyl Chloride (PVC) waterstops, asphalt seals with or without stainless steel strip. 12 gauge steel plate formed holes, joints filler and water proofing treatment over slab and corner joints at the location of joints as shown on the drawings or as directed by the Engineer-in-charge.

14.15.2Classification

The items covered under the specifications are as under :

Providing and fixing in position PVC water stop 305 mm/ 225 mm wide embedded in concrete with heat sealed joint, etc. complete as per drawings and specifications.

Providing and fixing in position PVC joints strip with 12 gauge stainless steel strip and stainless steel bolts and washer expansion anchors, etc. complete as per drawings and specifications.

Providing and laying asphalt seal in formed hole, at joints, including 12 mm diameter standard steam pipe duly fitted in 20 gauge sheet metal all along pipes

including clamps, nuts, bolts, couplings, plugs and steam supply filled with an approved 'H' grade asphalt etc. Complete as per drawings and specifications.

Providing and laying joint filler of approved quality in joints as per drawings and specifications.

Providing and fixing 20 gauge stainless steel strip (175 mm x 27 mm) with 12 mm dia, 80 long hexagonal head, stainless steel bolts embedded in concrete and nuts and washer, etc complete as per drawings and specifications.

Providing formed holes of different sizes and shape varying form 50 mm to 175 mm for joints including centering, shuttering, etc. complete as per drawings and specifications.

Providing and laying 6 layer water proofing treatment including 12 gauge 200 mm wide galvanised steel plate embedded in bituminous plastic cement, including fixing the plate at both corner joints to the standard galvanised shape anchor 20 mm wide 200 mm, providing flushing reglet and fixing the plate at corner joints with the help of 35 mm long 28 gauge galvanised barbed roofing nails in nailing concrete a the corner joints including providing 100 mm thick, 600 mm wide A. 20 S-200 RCC with 8 mm dia bars both ways over the steel plate including water proofing treatment etc. complete as per drawings and specification.

14.15.3 Application Publications

14.15.3.1 All methods of tests and welding procedure shall conform to latest Indian Standard Specification and other publication listed below unless otherwise specified.

14.15.3.2 Indian Standards

IS:702	Asphalt
IS:1322	**Bitumen felt**
IS:1346	Water proofing treatment 6 course.
IS:3384	Asphalt primer
IS:8004	Recommended procedure for welding of Flexible PVC (Flexible Polyvinyl Chloride)

14.15.3.3 Other Publications

American Society for Testing and Materials Designation D-638.

American Society for Testing and Materials Designation D-2240.

14.15.4 Polyvinyl Chloride (PVC) Water Stops

14.15.4.1 General

The dimension of Polyvinyl Chloride (PVC) waterstops, shall normally be as shown in approved drawings. The Contractor, however, will be permitted to use waterstops of any alternative manufacturer, such as waterstops with diamond shape and bulb, provided they conform with the specifications and the functional and construction requirement. For this purpose, the Contractor shall submit to the Engineer-in-charge for approval four sets of drawings, showing details of the waterstops, including shapes and details of intersections and splices between water stops of the same sizes and of different sizes. Fabrication and procurement of materials shall be made only after approval of the drawings by the Engineer-in-charge. Any fabrication or procurement of materials done prior to approval of the drawings shall be at the Contractor's expense. The Engineer-in-charge shall have the right to require the Contractor to make any changes in the drawings which may be necessary to make the finished installations conform to the requirements and intent of these specifications, without additional cost to the Employer. Approval by the Engineer-in-charge to the Contractor's drawings shall not be held to relieve the Contractor of any part of this obligations to meet all of the requirement of these specifications or of the responsibility for the correctness of his drawings.

One set of the above drawings will be returned to the Contractor, either approved, disapproved, or conditionally approved. All drawings that are disapproved shall be revised and resubmitted for approval, as directed.

The waterstops shall be dense, homogeneous and free from holes and other imperfections. The waterstops shall meet the material and test requirements given in concrete specifications. The cross-section of the waterstops shall be uniform along its length and thickness shall be symmetrical transversely. Tolerance from the dimensions given above shall be plus 5 mm in width, plus 2 mm in thickness and plus 1 mm for the rest.

Certified copies of laboratory test reports on the physical properties of the PVC waterstops and a certificate stating the PVC waterstops as furnished meet all other requirements of these specifications, shall be obtained by the Contractor from the manufacturer of the PVC waterstops and submitted to the Engineer-in-charge for approval. Three 1.5 m long samples of the PVC water stops shall be obtained by the contractors from the suppliers and submitted to the Engineer-in-charge. These samples shall be furnished atleast 60 days prior to embedding of any waterstops in the structures.

The contractor shall arrange to obtain the waterstops from the suppliers in rolls securely packed, containing a single length of not less than 12 linear metres and having inside diameter of not less 0.3 meter.

14.15.4.2 Installation

The location and embedding of the PVC waterstops shall be as shown on the drawings, with approximately one half of the width of the waterstops embedded in the concrete on each side of the joint. In order to eliminate faulty installation that may result in leakage, particular care shall be taken that the waterstops are correctly positioned and secured during installation. Where the bottom end of PVC waterstops contact rock at the base shall be embedded at a minimum depth of 30 cm into sound rock, All waterstops shall be so installed as to form a continuous water tight

diaphragm in the joint unless otherwise shown. Adequate provision shall be made to completely protect the waterstops during the progress of the work.

Additional vibration, over and above that used of adjacent concrete placement, shall be employed near the waterstops to assure complete embedding of the waterstops in the concrete. Larger pieces of aggregates near the waterstops shall be removed by hand during embedding to assure complete contact between the waterstops and the surrounding concrete.

Splices of waterstops shall be fabricated only by workmen who have demonstrated to the satisfaction of the Engineer-in-charge that they are sufficiently skilled to fabricate the required splices. Splices in the continuity of or at the intersection of runs of PVC waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric heat source shall be used to make all splices. The correct temperature at which splices should be sufficient to melt but not char the PVC material. All splices shall be neat with the ends of the joined waterstops in the true alignment. A meter box guide and portable saw shall be provide and used to cut the ends to be joined to ensure good alignment and contact between the surface joint. After splicing, a remoulding iron with ribs and corrugations to match the pattern of the waterstop, shall be used to reform the ribs at the splice. The continuity of the characteristic members of the waterstop design (ribs, tubular central axis, protrusions and the like) shall be maintained across the splice.

Where splices are required between waterstops of different sizes the splices shall be made as recommended by the manufacturer of the waterstops and drawings showing the details of the splices shall be submitted to the Engineer-in-charge.

Prior to embedding, the edges of the waterstop shall be secured to looped wire in the end bulbs to improve the concrete bond as shown on the drawings. The bars shall conform to the provision of Section-9 "Concrete works". The manner in which the waterstop is secured to the reinforcing bars shall be subject to approval of the Engineer-in-charge.

14.15.4.3 Asphalt Seal

14.15.4.3.1General

The contractor shall construct asphalt seals in contraction joints of dam intake and pump house and intake structure as shown on the drawings or as directed by the Engineer-in-charge.

14.15.4.4 Material

Asphalt fill hole shall be filled with 'H' grade asphalt or blow bitumen asphalt R 85/25. 11mm diameter heating pipes and fittings shall be provided in the formed hole for asphalt fill as shown in the drawing.

14.15.4.5 PVC Joints Strip

14.15.4.6 PVC joint strips : PVC joint strips with or without stainless steel metal strips shall be installed in the places shown on the drawings and elsewhere as directed. The

Contractor shall furnish the PVC joint strips, metal strip, expansion anchors, bolts and washers. The joint strips shall be furnished in not less than 3.5 m length. All PVC joint strips shall be stored in as cool place as practicable, preferable at 70^0 F or less, and in no case shall the rubber be stored in the open or exposed to the direct rays of the sun. PVC material for the joint shall have the physical characteristics as per para 17.15.4.1 of this section.

All PVC joint strips shall be extruded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity and other imperfection. Surface defects such as surface peel, flow lines, blisters, nonfills and air traps shall be minimum. Any defects which is not acceptable shall be repaired to the satisfaction of Engineer-in-charge or shall be removed from the finished product by cutting out a length of joint strip containing such defect.

The Contractor shall also furnish to the Engineer-in-charge with three 300mm samples of the PVC joints strips for testing for tensile strength and elongation by the Employer. The samples shall be cut from the finished product in the presence of the Engineer-in-charge. The contractor shall furnish samples at no extra cost to the Employer.

PVC joint strips shall not be installed until at curing of the adjacent concrete has been complete. The joint strips shall be installed as shown by close fitting butt joints and the location of all such joints shall be submitted to the approval of the Engineer-in-charge. The metal strips for the PVC joint strips shall be fastened to the concrete with, bolts as shown on the drawings. Where required, the metal strips shall be bent to conform to the angles formed by abutting surface.

14.15.4.6 Joint filler

The joint filler shall normally be as shown on drawing. The Contractor however, will be permitted to use, joint filler of the approved quality as per relevant Indian Standard, or any alternative manufacturer of joint filler, provided they conform to the specification and the functional and construction requirement The Contractor shall submit to the Engineer-in-charge for approval the proposal 30 days before for using such joint filler along with relevant certificate from manufacturer of joint filler.

The joints in the joint filler shall be scarfed, made tight and filled with suitable material so that mortar from the concrete will not seep through the opposite surface. The joint filler shall be racked out after the concrete has set.

14.15.5 **Water Proofing arrangement at the corners and joints in slab**.

The water proofing arrangements shall be provided on the roof at the junction of roof and the wall. The arrangement including providing fixing and laying 12 gauge G.I. plate embedded in 100 mm thick 600 mm wide RCC, including 28 gauge roofing nails of 30 mm long fixed in nailing concrete in the corner and providing and fixing flashing reglet and standard galvanized anchor strap of 200 mm long 20 mm wide, 6 layer of water proofing membrane, caulking compound etc. complete as per drawing and specification.

14.16 MISCELLANEOUS WORKS FOR CIVIL STRUCTURES

14.16.1 ROADWAY

The approaches to pump houses of Gouravelly reservoir shall be black-topped metallic road and shall consist of stone metal mechanically interlocked by rolling and bonded together screening and binding material, where necessary and water laid on a prepared subgrade. The road will be finished in accordance with the requirements of these specifications, description of item of work and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Engineer-in-charge.

14.16.1.1 MATERIALS

a) Coarse aggregates

Coarse aggregates shall be stone aggregate with impact value conforming to IS : 2386 and IS : 5640. The grading of aggregates shall be as under :

Size range designation	Sieve designation	Percent by weight passing the sieve
63 mm to 40 mm (For Stone metal)	80 mm	100
	63 mm	90-100
	50 mm	35-70
	40 mm	0-15
	20 mm	0-5

b) Crushed or Broken Stone

Crushed or broken stone shall be free of flat, elongated, soft and disintegrated particles and should not contain any excess of dirt or other objectionable materials.

i) Screening

Screening to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river-borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screening shall conform to the following gradings :

Size of Screening designation	Sieve designation	Percent by weight passing the sieve
10 mm	10 mm	100
	4.75 mm	85-100
	150 micron	10-30

ii) Binding Material

Binding material to be used for water-bound macadam construction shall comprise a suitable material approved by the Engineer-in-charge having plasticity index value of less than 6 as determined in accordance with IS : 2720 (Part V).

Application of binding material may not be necessary, when the screenings used are of crushable type such as moorum or gravel.

14.16.1.2 CONSTRUCTION OPERATIONS

a)Preparation of Subgrade

The subgrade 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.

b) Spreading Coarse Aggregate

The coarse aggregates (stone metal) shall be spread uniformly upon the prepared subgrade in two layers in such quantities so that the compacted thickness of each layer is 100 mm. Each layer is to be rolled separately but no binding material will be used in the first layer.

The spreading shall be done 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 uncompacted 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 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 more than 3 days in advance of the subsequent construction operations.

c) Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three-wheeled power rollers of 8 to 10 tonne capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer-in-charge. 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 road, in successive passes uniformly lapping 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 screenings. However, in the case of first layer, where screenings are not to be applied, compaction shall be continued until the aggregates are thoroughly keyed. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the ubgrade is

soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

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

d) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the inter-stices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screening are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings 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 screenings shall be so driven as not to disturb the coarse aggregate.

The screening shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms 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 filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

e) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

f) Application of Binding Material

After the application of screenings, binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled, during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling voids, forms a wave ahead of the wheels of moving roller.

g) Setting and Drying

After the final compaction of water-bound macadam course, the road shall be allowed to dry overnight. Next morning deficient spots shall be filled with screenings of binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer-in-charge 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.

14.16.2 Specifications for the work of preparation of road base, laying and compaction of road base, providing water-bound macadam base course and asphalt wearing course/carpet shall be done as per IRC/IS specifications applicable from time to time.

14.17 RAILING

14.17.1 R.C.C. Railing

Railing shall not be cast until the centering or form-work for the span has been removed, and the span is self-supporting. The type of railing to be constructed shall be as shown on the drawings. The railing shall be carefully erected, true to line and grade. Posts shall be vertical within a tolerance not to exceed 6 mm in 3 metres.

Forms shall either be of single width boards or shall be lined with suitable material duly approved by the Engineer-in-charge. Form joints in plane surface will not be permitted.

All mouldings, panel work and level strips shall be constructed according to the details shown on the drawings. All corners in the finished work shall be sheared and clean-cut and shall be free from cracks, spalls or other defects. Payment for railing will be made at the rate per running metres. The rate shall include cost of labour, material, tools, and plant required for doing the work complete in all respects as per specifications.

14.17.2 G.I. Railings

All pipes and all steel elements used for railing, terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanized.

All elements of the railing shall be free from abrasions, rough or sharp edges, and shall not be kinked, twisted or bent. If straightening is necessary, it shall be done by methods approved by the Engineer-in-charge.

The railing shall be carefully adjusted prior to fixing in place to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment. Welding may be substituted for riveting in field connections only with the approval of the Engineer-in-charge. The payment for G.I.

Railing will be made at the rate per running metre. The rate shall include cost of all labour, material, tools and plant required for doing the work complete in all respect as per specifications.

14.18 Guard Rail

the Contractor shall furnish and install guard rails at the location as shown on the drawings or as directed by the Engineer.

Prior to the work the Contractor shall submit to the Engineer for his approval shop drawings and installation method of guard rails.

The rails and posts shall be structured conforming to international standard and formed to the dimensions as shown on the Drawings or as directed by the Engineer.

Required bolts, nuts and washers shall be galvanized. The post shall be set to the required depth and be held firmly in place by concrete foundation.

After the guard rails are installed in place, painting shall be executed in accordance with the relevant provisions of the Specifications.

Reflector strip shall be attached to the guard rail wherever instructed by the Engineer and at maximum distance of 30 m along straight stretch.

Measurement for payment of guard rail shall be made at actual length in meter installed in service roads and accepted by the Engineer.

The unit prices for guard rail in service roads shall include all the cost for furnishing, installing and painting of guard rails and any other incidental works.

Guard rials installed in other construction roads including existing roads shall not be paid for separately, and the cost for which shall be included in the lump sum price of construction road in the Bill of Quantities.

14.19 Laying of Concrete Block

(1) General

The concrete block work shall be provided as indicated on the Drawings

Concrete block may be pre-cast / cast-in-situ and the volume of which should not be less than 0.3 m^3. Concrete mix should be of 1:2:4 with 20 mm nominal size of aggregate. In case pre-cast blocks proper arrangement for placement of the same without damage and according to the line and levels shall be made.

In case of cast-in-situ blocks casting is to be done over the bed itself. Alternate blocks are to be taken up for casting at one time. Placement of pre-cast block/cast-in-situ block should be done in such a manner as there should not be any continuous joints.

Measurement for concrete block shall be made as per gross volume of each block in cubic metres.

Rate for concrete block shall include:

i) Cost of find and coarse aggregate / cement etc.
ii) Mixing, placing, compaction
iii) Shuttering and curing
iv) Placement of block over prepared bed.

15FOREBAY BED LINING

15.1 GENERAL: These specifications apply to:

(a) Clearing site, preparation of sub grade in soils and rock, providing under drainage, pressure relief arrangements, anti salt treatment, placing model sections, laying plain cement concrete with machine crushed hard broken graded quartzite/ granite/ other than granite metal of 40 mm/ 20 mm. maximum nominal size and using cement level of not less than 310 Kgs. per cubic meter of concrete to yield a 28 days characteristic compressive strength specified based on laboratory tests for bed and sides respectively using conventional placement of concrete lining.

(b) If during construction, it is found necessary to alter the canal sections and side slopes without alterning the thickness of lining, the contractors shall be informed in writing of such changes.

(c) The scope of work also includes the following :

(i) Dewatering the canal section for preparing the base for lining and for laying concrete lining.

(ii) Providing necessary, under drainage arrangements consisting of longitudinal and transverse drains, pressure relief valves as per drawings.

(iii) Providing filter materials of approved quality as per designs.

(iv) Bed and side lining of the cement concrete with machine crushed hard broken graded Quartzite/granite/ other than granite metal of 40 mm./ 20 mm. nominal size and using cement of not less than 310 Kgs/cum. of concrete to yield a characteristic compressive strength specified based on laboratory tests respectively.

(v) Providing grooves for joints by cutting the concrete to the required depth and width as per drawings.

(vi) Curing.

(vii) Filling joints:

(viii)

15.2APPLICABLE PUBLICATIONS:

All concrete, its constituents, methods and procedures of manufacture shall conform to Indian Standard Specifications and other publications listed below unless otherwise specified.

Indian Standards

1.IS : 456 -1978 Code of practice for plain and reinforced concrete (Second Revision) (Amendment No. 1).
2. IS : 3873-1978 Code of practice for laying in-situ cement concrete lining first Revision of canals (First Revision)
3. IS : 2505-1980General requirements for concrete vibrators immersion type.
4.IS: 2506- 1985General requirements for screed board concrete vibrators.
5.IS :3366-1965 Specification for pan vibrators.
6. IS : 3558-1983 Code of practice for use of immersion vibrators for consolidating concrete.
7. IS : 4558-1983Code of practice for under drainage of lined canals.(First Revision)
8.IS : 5256-1968 Code of practice for sealing joints in concrete lining on canals
9.IS : 3085-1965 Methods of test for permeability of cement mortar and concrete..
10.IS : 1199-1959Method if sampling and analysis of concrete.
11.IS : 516 -1959 Method of tests for strength of concrete (Amendment No.1)
12.IS : 5529-1985Code of practice for insitu-permeability test. (part I&II)
13.IS: 9103-1979Specifications for admixtures for concrete.
14.IS : 2720-1980Methods of test for soils Determination of water (Part – 7) content –dry density relation using light compaction (second revision)
15. IS : 9451-1985Guidelines for placing lining for Canals in expansive soils. In addition to the above I.S. codes, the specifications of A.P.S.S. and manual for quality control and inspection shall also be complied with.

15.3PREPARATION OF SUBGRADE:

15.3.1Scope :

Preparation of sub grade (Back filling) to canal side and bed lining with CNS soils of approved quality, obtained from available canal spoil including cost and conveyance of soils, Clearing the site, dewatering if necessary, treatment of the soil laying moistening compacting to 98% proctor's density with suitable compacting equipment, trimming, all water leads, material leads, lifts, delifts, and all the operations necessary to complete the finished item of work to specifications, as per drawings or as directed by the Engineer-in-charge.

15.3.2 CLEARING SITE:

The area proposed for lining the canal as a whole shall be cleared of all objectionable material. Any waste material contained from such site clearance shall be disposed off in a manner directed by the Engineer-in-charge. The cost of this operation shall be deemed to have been covered under the rates quoted for canal lining.

15.3.3 GENERAL :

The provisions of this para shall apply to the preparation of all sub-grade up on which concrete lining is to be laid. The work of trimming canal section upto the under side of concrete lining and preparing sub-grade for concrete placement includes removal of proud section. Proud equivalent to thickness of lining on sides and in bed on the underside of lining should be left un-excavated and the removal of this proud should be done prior to laying of lining but in no case, should the time interval exceed 3 days in normal weather and two days in adverse weather conditions. It shall be ensured that the subgrade is made thoroughly moist with fine water spray, through deployment of proper nozzles, to a depth of about 15 cms to prevent it from absorbing water from the freshly laid concrete.

Soil in all reaches should be tested for salt content before lining is started. Where the salt content is over one percent or sodium sulphate is over 0.36 percent, the sub grade should first be covered with about 2 mm. thick layer of bitumen, if ordered by the Engineer-in-charge It shall be treated in accordance with para 4.3 I.S. of 3873-1978.

Preparation of sub grade for concrete lining shall conform to clause 4.1 to 4.5 of IS:3873-1978.

Wherever rock is over excavated it shall be filled as specified under subsequent paras.

At the end panels of existing lining against which lining is to be placed under these specifications, all these materials shall be removed and all voids beneath the existing lining shall be refilled and thoroughly compacted.

15.3.4 SUB -GRADE :

i) Preparation of sub grade consisting of earth.

a) The sub grade shall be prepared, dressed and rolled true to level and according to the required cross- section of the canal to form a firm compacted bed for the lining.

b) The contractor shall place selected bedding material, test profile true to the cross section of the canal at times and places designated by the Engineer to show the adequacy of his construction procedures for laying bedding materials. The test sections shall conform to clause 4.5.2.of I.S. 3873. - 1978. The cost of this operation shall be deemed to have covered in the rates quoted for side and bed lining.

c) In other than predominantly sandy reaches where the dry density of the natural soil is not less than 1.8 gm. per cubic centimeter, initial excavation shall be done up to about 300mm**.** above the final section and the cutting to final shape shall be done immediately before lining. The compaction shall conform to Clause 4.5.6. of IS 3873-1978.

d) If at any point material of prepared sub grade has been excavated beyond the neat lines required to receive lining, the excess excavation shall be filled in horizontal layers with suitable semi pervious soil material compatible with the sub grade material moistened and thoroughly compacted in accordance with Clause 4.5.5. and 4.5.6of I.S. 3873-1978. Where placing and compacting bedding materials is on slopping foundation, the layers may be placed parallel to the surface of the foundation. If at any point, the foundation. material is disturbed or loosened during the excavation process or other wise, it shall be moistened if required, and thoroughly compacted by tamping, rolling or other approved methods to form firm foundation for placing the concrete lining**.** Slope compactors may also be used for effective compaction of subgrade.

e) In bed, where the dry density of the natural soil is less than 1.8 gm**.** per cubic centimeter and sub soil water is near the sub grade, the consolidation shall be done by under cutting the bed by 7.5cm and then ploughing upto 15.0cm**.** below the subgrade level. Theloosened soil shall then be recompacted with suitable devices. All along the canal alignment the raincuts on the banks shall be filled up with approved soil and shall be compacted adequately to required lines, dimensions and levels.

f) In bed where the sub soil water is low, requiring no dewatering and the dry density of the natural soil is less than 1.8 gm**.** per cubic centimeter, the consolidation shall be done by digging the canal up to sub grade level and after loosening the earth below subqrade up to 15.0cm**.** by disc harrows, or ploughing and compacting the same to a layer of 11.0cm. After that, the second layer of 15.cm**.** of earth shall be laid over the compacted layer by taking earth from lip cutting and compacting this to a depth of 11.00cm. The compacted layer of 7.0 cm above the subgrade level**.** shall be removed and the subgrade brought to design profile before laying the lining.

g) Consolidation on sides shall be done by suitable slope compactors to obtain a minimum dry density of not less than 90-98% of the density at optimum moisture content obtained in accordance with IS : 2720(part vii) 1965**.** Compaction by manual labour shall not be permitted.

ii) Preparation of sub grade consisting or rock.

a) The sub grade in rock shall be excavated to the required cross section. Final cutting for 450-600 mm**.** in hard rock shall be carried out by**,** wedging**,** barring controlled blasting or trimming with the help of suitable equipment. No extra payment will be made to this.

b) The bed and side slopes of the canal excavation profile over which the bedding material,. under drainage and pressure relief arrangements are to be placed and over laid with lining shall be finished accurately to true and even surfaces and to the dimensions shown on the drawings.

c) All excavation including over breakages below the lines of the underside of lining shall be back filled as follows:

In slopes : In slopes, the selected bedding material shall be semi pervious material forming, the bulk of back fill with smaller aggregate filling the voids**,** and a layer of gravel as binding material duly compacted with rammers to form a firm backing for the lining (IS: 3873-1978).

In bed : In case of bed, the selected bedding material shall be rock spells and chips available from canal cutting duly compacted with Diesel Road Roller to form a firm backing to lining (IS: 3873-1978).

Tolerance in Excavation :- Excavated profile provides the final base for lining and tolerances should be comparable to the following :

Departure from established alignment :
(+) or (-) 2 mm**.** on straight section:
(+) or (-) 50 mm**.** of tangents, and
(+) or (-) 100 mm**.** on curves.
(+) or (-)20 mm**.** Departure from established alignment.

The above tolerances shall be negotiated gradually, through smooth transition in a length of 50 m**.** No over- run in excavation. Filling with the materials as directed by the Engineers, shall be paid to the contractor.

The selected bedding material in the cases of bed and sides of canal profile in normal soils shall be graded filter material comparable with sub grade material and thoroughly compacted.

iii) Preparation of sub grade consisting of expansive soils. (IS : 9451-1995)**.**

(a) Field and laboratory experiments shall be carried out to determine the physical**,** texture, engineering and chemical properties of the black cotton soils/expansive soils and evaluate the swelling pressures of soils in various reaches to establish the thickness of CNS**.** layer required so that the determination is within the permissible limit.

In respect of the provision of CNS layer is worked out from the consideration of swelling pressure. However, the thickness of CNS layer to be provided on slopes shall, in addition, be governed by the construction considerations viz., from rollable width consideration for achieving effective compaction. However making due allowance for field controls, variations in the properties of CNS materials in the field an optimum thickness of 600 mm**.** normal to the slope shall be used in the channels of discharge more than one cumec. The thickness shall be appropriately decreased to 300 mm**.** (150mm**.** in small section of less discharges) channels. Filling and compaction of CNS material in such channels shall be done by pad/file and cut method as specified in the drawings.

15.3.5 C.N.S. BACK-FILL:

Formation of CNS soils backing to lining for bed of the forebay including breaking clods, sectioning, watering, and consolidation with 8-10 ton power roller to 98% proctor, density at optimum moisture content including spreading of horizontal layers of not more than 100 to 150mm thick upto the top level of P.C,C . lining/ cast-in-situ lining.

The surface to receive the filling shall be first cleared free from all roots, vegetation or spoils and then wetted and rolled thoroughly. The C.N.S. soils to be used for filling shall be free from salts or organic or other deleterious mater. All clods of the soils selected shall be broken to small pieces less than 100 mm**.** size. No stones cobbles having maximum dimensions more than 100mm. size shall be placed in the fill. Filling shall be done in layers not exceeding the compacted thickness of 100 to 150mm. each layer being watered and compacted before succeeding layer is laid. If the moisture is below the optimum moisture content for the given compaction. Then the required water shall be added by sprinkling if the moisture content in the soils is more than the optimum moisture content then it shall be allowed to dry down to the optimum moisture content. The moisture content shall be uniform throughout the layer of material. Compaction shall be achieved by using appropriate power roller. The number of passes shall be determined by testing the density of the compacted soil at site after taking trial compaction for specified passes of the, roller. The roller shall be taken close to the sides of the trench. In cases where the compaction by roller. is not possible compaction shall be done as specified by the Engineer-in-charge. Care shall be taken to ensure that over compaction does not take place. The CNS material shall be filled in layers not exceeding the 225 mm compacted thickness of 100 to 150mm. up to T.B.L. and shall be consolidated with 8 to10ton power roller to the proctor’s density of 98%at

optimum moisture content.Serrations should be provided in expansive soil to present contact slides between CNS. materials and expansive soil .The work shall be tackled in continuous horizontal layers. On resuming work each day or after an interval of few day or when work is not done in continuity the previous layer shall be well raked and water sprinkled over it before the fresh layer is laid and compacted. Special precautions shall also be taken while rolling the spread soil near structures, conduits, sluices, etc., Quality control tests shall regularly be carried out to determine the suitability of the soil used for filling and to control moisture content to ensure that the specified density is obtained. All. tests shall be done in accordance with the relevant Indian standards. The frequency of the test shall be as determined by the Engineer-in-charge. The work shall be done to the construction profile.

The canal section including the thickness of the lining shall be excavated in CNS soils and canal sides and bed are trimmed to receive P.C.C slab lining and cast -in-situ lining respectively

The soils excavated shall be rehandlied and used for forward reach as directed by the Engineer. No extra payment will be made for the excavation of CNS soil in canal section and rehandling the soils as above separately.

i) Gradation of C.N.S Soil :

1. Clay (less than 2 microns) -15 to 20%
2. Silt (0.06mm-0.002mm.) -30to 40%
3. Sand (2mm -0.06mm.) -30to 40%
4. Gravel (Greater than 2mm.)-0to10%

i. The CNS**.** material shall be non-swelling, with maximum swelling pressure of 10KN/m2 when tested in accordance with IS: 2720(Part-41)-1977at field moisture content oven dry condition

ii. The minimum shear parameters may range from 10.3422 Kn/m2 and 25^{o} to 27.5790 KN/m2 and 12^{o} to 14^{o}

iii. Index properties:

1. Liquid Limit. Less than 50% but greater than 30%
2. Plasticity Index Less than 30% but greater than 15%

a) If the expansive clay is in thin layers or in small pockets in an otherwise suitable sub grade shall be over excavated as determined by the Engineer-in-charge. and replaced with suitable non-expansive soil and compacted suitably.

b) After the canal prism has been shaped to a reasonably true and even surface, selected bedding materials shall be placed on thoroughly wetted surfaces in layers of 15CM.maximum thickness to bring the bedding material to a height where it can be trimmed to form a true and even surface upon which to place the concrete lining. Each layer shall be moistened and thoroughly compacted as per specification 3.2. Where the bedding material is placed and compacted on a slopping ground layers may be placed parallel to the surface of the foundation. The moisture content of the bedding material at the time of compaction shall be optimum. The compaction procedures used shall be as described below.

i) The contractor shall place demonstration or test sections of selected bedding material at time and places designated by the Engineer-in-charge to show the adequacy of his construction procedures for placing and compacting the bedding material. The test section shall conform to clause 4.5.2 of IS 3873-1978.

ii) The bedding material shall be placed to sufficient thickness in the test sections to allow practical density testing of the compacted material. The dimensions and densities of the compacted bedding materials shall be acceptable to the Engineer-in-charge. The procedures shall then be used to compact the selected bedding material on the remaining work.

iii) When placing and compacting selected bedding materials on a sloping foundation, the layers may be placed parallel to the surface of the foundation. If at any point the foundation material is disturbed or loosened during the excavation process or otherwise it shall be moistened if required and thoroughly compacted by tamping, rolling or other approved methods to form firm foundations upon which to place the concrete lining. The bottom and side slopes, including the surfaces of compacted embankment, compacted selected bedding materials and compacted back fill over which concrete lining is to be placed shall be furnished accurately to true and even surfaces to the dimensions shown on the drawings. The loading, handling, transporting and placing of the selected bedding material is subject to approval of the Engineer-in-charge and shall be such as will result in a uniform mixture of the material being placed without separation or segregation. Selected bedding materials required shall be obtained from excavation in areas where material in excess of that required to construct the adjacent embankment is available or the material approved by the Engineer-in-charge.

iv) Immediately prior to placing the first lift of bedding material, the surfaces of excavation and embankment to receive the material shall be adequately wetted to a depth of 15cm. or to impermeable material whichever is less as approved by the Engineer-in-charge.

v) Suitable materials trimmed from the canal shall be used to complete canal embankments, to construct road embankment, for selected bedding material in the forward areas. Where material suitable for selected bedding as determined by the Engineer-in-charge is encountered during trimming operations and cannot be placed in one continuous operation, such material shall be stockpiled along the right-of way where designated by the Engineer-in-charge.

15.3.6 MEASUREMENT AND PAYMENT:

All linear measurements shall be in meters corrected to 0.01M. and volume shall be worked out to nearest to 0.01 Cum. The items covered under their are ..

1) Mark out
2) Cost and conveyance of CNS. soil to the site of work.
3) Filing the C.N.S. soil in layers of not exceeding 100 to 150mm. thick and consolidation with appropriate power rollers to a proctor's density of 98% at optimum moisture content.
4) Cutting the canal section, including the thickness of lining in the compacted C.N.S soil
5) Rehandling the extra excavated CNS. soil to the forward reach.
6) Forming and removal of steps and ramps, benching battering, formation of temporary tracks for diversion of surface flows, bailing out seepage water and such other temporary arrangements unless otherwise specified.

7) Shrinkage allowance.
8) No separate payment will be made. It shall be included in the price bid quoted in the Bill of Quantities.

15.4 UNDER DRAINAGE:

15.4.1 General:

For a lined canal where the ground water level is higher or likely to be higher than the water level inside the canal so as to cause damaging differential pressure on the lining or where the subgrade is sufficiently impermeable to prevent free drainage of the under side of lining in case of rapid drawdown, pressure relief arrangements for under drainage shall be provided suitably as indicated in the drawing in accordance with IS: 455-1968.

15.4.2 FILTER DRAINS:

a) Scope : Forming longitudinal/transverse filter drains of Specified size in bed with 10 mm to 40mm machine crushed metal of specified variety and sand including cost and conveyance of all materials, labour charges for laying with leads, lifts, delifts, seigniorage charges, sampling and testing, dewatering, packing and all other incidental and operational charges necessary to complete the finished item of work as per drawings and as directed by the Engineer-in-charge.

b) Whenever necessary, longitudinal/transverse filter drains shall be laid in the concrete lining true to the canal grade as shown in the drawings or as directed by the Engineer-in-charge. The number of layers comprising the filter, thickness of each layer and the materials to be used shall be as shown in the drawings. The filter material shall be clean, round and well graded sand or coarse aggregate the requirements of grading of which will be established in the field laboratory on the basis of mechanical analysis of adjacent materials. Particles of decomposed rock debris, wood vegetable matter or other deleterious materials shall not be permitted in the filter. Before placing the filter the bed shall be prepared as explained in the above paragraphs.

c) The longitudinal drains shall be laid to the grade of the canal while the transverse drains in bed shall have a fall towards the centre of the canal bed from the edge as shown in the drawing. The sand shall be clean, round and well graded. Before placing the filter, the bed shall be prepared as specified in paragraph above.

d) No separate payment will be made. It shall be included in the price bid quoted in the Bill of Quantities.

15.4.3 Pressure relief arrangement:

a) **Scope** : Laying and fixing of porous concrete plugs/flap valves in position in filter pockets including (a) Manufacturing of plugs, using 20 mm size machine crushed/ hand broken aggregate of specified variety and Cement of specified quantity for each plug (or) Manufacturing of flap valves consisting specified internal diameter with P.V.C.Pipe, with P.V.C. flange and rubber flap with all accessories and (b) excavation of pit for laying filter pocket and filling the filter pocket with filter materials including cost and conveyance of cement and all other materials, seigniorage, charges, labour charges for Manufacturing of plugs/flap valves, excavation of filter pocket, filling of pocket with specified grade of filter material, form work ,moulds machine mixing

manufacturing, curing, sampling and testing, laying and fixing in position with all leads, lifts, delifts, dewatering, all water leads, and all other incidental and operation charges necessary to complete the finished items of work as per drawings and as directed by Engineer-in-charge.

b) The porous plug/flap valve shall be installed in position in the filter drains in the bed normal to the canal slope in the local filters in the sides at the location shown in the drawings or as directed by the Executive Engineer.

c) **Flap valves:** Flap valves consisting of 40mm internal diameter polyvinyl chloride (P.V.C)pipe with P.V.C. flange and rubber flap shall be fabricated with all accessories as shown in the drawings. The flap valve shall be designed as to open automatically at a differential head of not more than 100 mm of water. The contractor shall arrange the performance tests of all the flap valves and those that do not conform to the specified functioning shall be rejected. Installation of flap valves shall not be permitted without the acceptance test of the same.

The flap valves shall be installed in position in the filter drains in the bed and normal to canal slope in the local filters in the side at the location shown in the drawings or as directed by the Engineer-in-charge.

The tendered unit price for this item of schedule 'A' shall be inclusive of the cost of manufacture, handling, testing and installation in position with excavation of pocket and filling with filter material complete and shall be inclusive of all those operations as well as those defined in the nomenclature of the item.

d) **Porous plug**:

1) Wherever specified, the porous concrete shall be composed of one part of cement and 4parts of coarse aggregate (viz no fine concrete) by weight of not. more than 20 mm. size Only so much water shall be used in concrete as required to produce a paste which will coat the particles without filling the voids. In placing porous concrete in moulds, care shall be taken to ensure that it is not over tamped or compacted so as to reduce its porosity. The porous plugs after hardening (i.e. attains final setting) should be sprinkled and kept most for atleast 14days. The compressive strength of porous concrete at 7days age as determined by tests on 15 cm diameter, 30cm height cylinder should not be less than 70kgs/sq.cm and the porosity at 7days be such that water shall pass through slab of concrete 30cm thick at a minimum rate of 500liters/min/square meter of the flap with a constant 10cm depth of water on the slab.

2) Pre cast porous concrete plugs of 300 x 300 mm section size extending to full depth of canal lining shall be provided in bed and sides as shown in the drawings with filter materials.

3) The porous plugs shall be so inserted into the lining that their porosity is not lost or reduced when the concrete for the lining is vibrated.

15.5LAYING OF C.C. LINING:

a) **Scope** :- Laying cement concrete lining of specified thickness in M10 grade using a minimum cement of 310kg/cum. of concrete and 40mm. MSA machine crushed graded metal of specified variety including cost and conveyance of cement and all other materials of approved quality, seigniorage charges, sampling and testing preparing the

base for laying concrete with weigh batching plant, machine mixing, conveyance of concrete with transit mixtures, placing of concrete in position and finishing SL 450 with paver finishing upto bed width of 2.00 M for less than 2.00 M bed width with acro gantry either by using machinery or by manual labour as specified in schedule 'A'. vibrating, finishing cutting grooves for panel joints, dewatering, curing, with water with a net work of pipeline system, hire and. operational charges of machinery, all leads, lifts, delifts, all water leads and all other incidental and operational charges necessary to complete the finished item of work of cast -in-site lining in bed/sides as per drawings and as directed by the Engineer-in-charge.

b) The work of laying in-situ cement concrete canal lining shall generally conform to IS. :3873--1978 and all concrete shall be governed by IS: 456-1978 concrete canal lining shall be done in the canal prism as shown in the drawings using well graded aggregate for 10 cm. thick lining shall be 40 mm. It shall be 20 mm. for lining thickness of 7.5 cms.

c) (i) Concrete shall be produced in a stationary weight batching and mixing plants/plants of adequate capacity installed at a suitable place by the contractor and concrete conveyed to the placement site/sites in transit mixes. The slump of concrete at placement site shall range shall from 50 mm. to 65 mm. with a water cement ratio of less than 0.6.

Alternatively : ii) Mobile self loading weigh batching mixing transporting equipment with adequate capacity of mixer drum, shall be deployed by the contractor for production of controlled concrete and transportation to the placement site/sites. Number of such equipment to be deployed shall be such as to achieve the construction schedule targets.

Alternatively., The Engineer-in-charge may allow the use of standard portable/stationary concrete mixes along with weight batching and measuring arrangement proportioning and protection of concrete and placement of concrete with conventional (manual) method.

15.6 Testing :

Concrete cubes at random shall be collected during laying concrete and shall be tested in the labs. If results are substandard, the entire work of the day on which cubes were collected shall have to be replaced by the contractor at his own cost.

15.6.1 Core Test : Securing and preparing test specimens from hardened concrete.

As specified in clause 4.1 of IS 1119-1959 (Bureau of Indian Standards Methods of sampling and analysis of concrete) cores shall be taken at random so as to ascertain the strength, permeability, thickness of concrete layer and cement content used. As the canal lining work progresses testing of output shall be on regular basis. Accordingly, to evaluate the quality of concrete lining completed, cores shall be taken as determined by the Engineer-in-charge. Broadly it could be one core each from bed lining completed and cured for 28 days in respective reaches. Frequency of drill cores shall be determined by the Engineer-in-charge. Broadly it could be one core each from bed lining per 200 Square meters (or even more at the discretion of Engineer-in charge of in -situ lining.

The cores shall be tested for compressive strength and if needed for permeability ,and cement content etc., as well. The cores shall be tested, for 28 days compressive strength.

The contractor shall allow all facilities and cooperation towards collection of cores. The testing of cores shall be carried out at the testing laboratories set up at the site or. at any other laboratory that the Engineer may so decide and the results given there by shall be considered correct and authentic by contractor. The contractor shall be given access to all operations and tests that may be carried out as aforesaid so that he may satisfy himself regarding the procedure and methods adopted . The payments shall be made only after satisfactory core test results acceptable to the Engineer-in-charge.

A standard test cylinder has a diameter one- half of its height (viz the length-L, diameter-D, ratio is 2). However, the cores taken from in situ lining shall not have these relative dimensions and consequently L/D ratio will not be 2. Accordingly the test strengths of the cores need to be corrected. The curve in Attachment- 1 may be used to correct the indicated strengths to make them comparable with those obtained from standard specimens. The contractor shall stack the cores properly in the sheds.

The criteria of acceptance of core strength shall be as outlined in IS : 456-1978.

15.6.2 Placing and compaction :

Sub-Grade well in advance for placement of lining. the sub -grade over which concrete is to be laid should be moistened adequately through very fine water spray so as to be thoroughly moist (but not muddy) so that water cannot get withdrawn from freshly placed concrete. Spray nozzles should be used to assure an even application of moisture and to prevent local erosions.

15.6.2.1

a) Placing of concrete shall not be started until all form work, installation of parts to be embedded and preparation of surface upon which concrete is to be laid have been completed. All absorptive surfaces against which concrete is to be laid shall be moistened thoroughly so that moisture will not be withdrawn from freshly placed concrete. The surfaces, however, shall be free from standing water and mud.

b) In the placement register containing the list of various, work items in sequential order, the contractor or his representative shall write, " completed preparation of sub grade, earth work, installation of parts to be embedded as per specifications and ready for placing concrete and sign. Then the authorized representative of the Engineer-in-charge shall inspect and write in the Register against the item allowed for concreting; and sign. Then only, placing of concrete shall be commenced by the contractor. If concreting is not started within 24 hours after approval, it shall be got approved again.

c) Concrete shall be placed only in the presence of a duly authorized representative of the Engineer-in-charge.

d) Hand mixing of the concrete shall not be permitted under any circumstances.

e) Concrete shall be deposited in all cases as nearly as practicable in its final position and shall not be allowed to flow in a manner to permit segregation. Excessive separation of the coarse aggregate caused by allowing the concrete to fall freely from. too great height or at too great angle from the vertical shall not be permitted

and where such separation would otherwise occur the Contractor shall provide suitable means to convey the concrete without allowing such separation.

f) Concrete shall be deposited and spread on the bed of the canal as indicated on the drawings. Concrete may be so laid as to facilitate placing, vibration, finishing and curing operations. Concrete required for keys as shown on the drawings shall be laid after placing side panels PCC. as directed by the Engineer-in-charge.

g) The design mix for lining shall to secure dense concrete of required strength for that grade.

h) The compaction shall be with suitable vibrators approved by the Engineer-in-charge. and it shall be effective so as to have durable impermeable concrete.

i) The concreting near the joints shall be done with utmost care so as to avoid segregation and collection of loose place of aggregate along form work which may result honey combing.

j) The concrete near the junction of the side concrete panels and bed concrete shall be done as shown in drawings such that both shall rest firmly against each other to resist any back kick from external hydrostatic forces.

k) When concrete placing operations are stopped for the day, interrupted because of break down or delayed by other causes of where the contractor selects to construct a joint such as would result from constructing one of the lining in one pass, the edge of the fresh concrete lining shall be bulk headed to a surface normal to the lining along transverse and longitudinal lines. Before placing operation are resumed the surface of the hardened concrete shall be prepared as construction joint. when ever a substantial break down occurs in the concrete production or concrete transportation system, a joint shall be formed as close to the face of the fresh concrete as possible.

l) The fresh concrete shall then be placed against the existing concrete with the full groove for required contraction joint formed in between them. The completed groove shall be sealed with sealing compounds as per clause 6.3 of IS : 3873-1978 and as shown in the drawings.

m) The contractor should use stationary weigh batching plant, transit mixtures, conveyer belt or any other machinery for transporting concrete and pavers for laying concrete. The quoted rates shall include hire operational charges of all the machinery, setting of machinery, dismantling of machinery and any other contingent works for the movement of machinery and making good after laying of lining.

n) **Compaction** : The concrete shall be compacted with vibrators to give a dense concrete which is durable and impermeable ensuring the desired strength. Concrete shall not be over vibrated. The vibration shall be sufficient to remove all undesirable air voids from the concrete including air voids trapped against the forms. After consolidation. the concrete shall be free from aggregate pockets and honeycomb areas and shall be classed against all surfaces of forms and embedded materials. All concrete shall be properly consolidated before initial setting and should not be subsequently disturbed.

Form vibrators shall be used in conjunction with slip form lining machines for consolidation. The Engineer-in-charge may remove samples of hardened concrete for testing and examination and the contractor shall replace at no extra cost to the department concrete from which such samples are removed.

15.6.3 Finishing :

a) The Contractor shall notify the Executive Engineer before commencing concrete finishing. Unless inspection is waived in each specific case, finishing of concrete lining shall will be performed only when a representative of the Engineer-in-charge. is present concrete surfaces will be tested by the Engineer-in-charge in accordance with para 5.6.1, where necessary to determine whether the concrete surface is within the specified tolerances. Finished concrete which is not in the specified tolerances shall be repaired as detailed below.

b) Immediately on the removal of forms, unsightly ridges or lips shall be removed and undesirable local bulging on exposed surfaces shall be remedied by tooling and rubbing. All exposed concrete surfaces shall be cleaned of impurities lumps or mortar or grout and unsightly stains.

c) Repairs to concrete surfaces and additions where required shall be made by cutting regular openings not less than 70 mm depth into the concrete and placing fresh concrete to the required lines. The chipped openings shall be sharp. The fresh concrete shall be reinforced and chipped and troweled to the surface of the openings, the mortar shall be placed in layers not more than 20 mm. in thickness after being compacted and each layer shall be compacted thoroughly.

d) The surface of concrete finished against forms shall be even smooth and shall be free from projections, pockets, honeycombing and other objectionable defects.

e) The top portions of the side slopes of the canal lining extending 1.5 meter vertically below the top of the lining shall receive a nonskid, longitudinal brush finish as approved by the Engineer-in-charge.

f) Use of any finishing tool in areas where water has accumulated shall be prohibited and all finishing operations shall be delayed until the water has been absorbed evaporated or removed by draining, mopping or such other means.
(p)

15.6.4. Tolerances :

The permissible tolerances for the canal lining shall be as under in accordance with section 5.3 of IS : 3873-1978.

a) Departure from Established, alignment	$\pm$ 20mm on straight reaches and + 50mm on partial curves or tangents.
b) Departure from Established grade	$\pm$ 20mm on small canals.
c) Variation in thickness of lining.	$\pm$ 10% provided average thickness is not less than specified .

15.6.5 Curing :

The bed lining shall be water -cured for 28days through provision of earth bunds of small height so that a column of water is available above the lining.

The joints of plain cement concrete slabs lining on side slopes shall be water cured through sprinkling of water at regular intervals for at least 21 days.

The Engineer -in-charge may instruct contractor to provide pipe line system and sprinklers for curing of the lining work, if the Engineer-in-charge feels that the manual curing is not sufficient. The contractor shall abide by the instructions and erect the pipe line system the quoted rate shall include for erection of pipe line system and dismantling of the pipes after curing instead of manual curing if the work involved is more in length and quantity.
If the contractor fails to do curing to the satisfaction of the Engineer, the latter shall make arrangements for curing at the risk and cost of the contractor or the lining work will be pulled down. The lining so pulled down shall be rebuilt by the contractor at his own cost.

15.6.6 Testing of Concrete and acceptance of work:

a) General : Systematic testing of the raw materials for concrete as well as the concrete shall be done both while it is fresh and after it has hardened by the quality control and inspection Division on representative samples taken at the site of laying the concrete in accordance with relevant Indian Standard Specifications.

b) Sampling Procedure and frequency :i) Sampling Procedure : A random sampling procedure shall be adopted to ensure that each concrete batch has a reasonable chance of being tested, that is the sampling should be spread over the entire period of concreting and cover all mixing units.

(ii) Frequency : The minimum frequency of sampling of concrete of each grade shall be in accordance with the following.

Quantity of concrete (cubic meter)	Number of Samples
1- 5	1
6-15	2
16-30	3
31-50	4
51 and above	4plus one additional for each additonal 50 cubic meters or part there of

NOTE : At least one sample shall be taken from each shift.

iii) **Test Specimen** : Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purpose, such as to determine the strength of concrete at 7days or at the time of striking form work, or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing by accelerated methods as described in IS: 9013-1978. The specimen shall be tested as described in IS : 516-1959.

iv) **Test Strength of Samples** : In all cases, the 28 days characteristic compressive strength specified based on laboratory tests shall be the criteria for acceptance or rejection of the concrete in so far as the strength of plain cement concrete lining is concerned.

The test strength of the samples shall be the average of there specimens. The test strength shall be greater than the specified strength. The over all coefficient of variation shall not be more than (+) 15 percent of the average for the three consecutive samples tested, not more than 20 percent of the specimen strength shall be less than 80% of the specified strength.

Contractor shall provide necessary skilled labour and facilities for transport, collection of samples, cores etc., and shall remain present at the time, when the samples, cores etc., are taken. Testing shall be carried out at the testing laboratory at the nearest Lab, or at any other laboratory that the Engineer may decide upon and the results given thereby shall be considered as correct and authentic and acceptable to the contractor. The contractor shall be given access to all operations and tests that may be carried out as aforesaid. All testing charges are to be borne by the contractor.

v) **Core test :-** The points from which cores are to be taken number of cores required shall be at the discretion of the Engineer-in-charge. In no case however shall, fewer three cores be taken and tested. Core shall be tested as described in IS : 516- 1959.

15.6.7 Acceptance Criteria:

a) The cores shall be tested for 28 days compressive strength. These shall be inspected, examined for segregation /honey combing and checking the thickness of lining. The Engineer-in-charge may also arrange to test the core for permeability and cement content, if considered necessary. Concrete in the member represented by core test shall be considered acceptable if the average equivalent cube strength of cores is equal to at least 85 percent of the cubic strength of the grade of concrete specified for the corresponding age and no individual core has a strength not less than 75 percent.

b) The density of concrete shall not be less than 85 percent of specified density of 2400kg/m3.

c) In case the concrete does not confirm to the accepted criteria for strength as specified above, the Engineer-in-charge reserves the right to reject the work or accept the same at a reduced rate derived from tendered rate and as approved by him after examining all aspects and provided structural integrity is not effected. In case, the cores taken from concrete lining panels exhibit heavy segregation or honey combing the Engineer shall reject the concerned panels and the contractor shall have to dismantle the same and have to cast new panels at his expense.

Whenever necessary for the purpose of obtaining economy , workability, density, impermeability, durability strength or on account of variation in the quality and gradation of aggregates or other materials, except cement the Executive Engineer shall based on laboratory tests make necessary changes in the proportion of mix and vibrators. Contractor shall have to affect these changes and will not be entitled to any compensation on account of such changes. Relevant para of IS : 456-1978. shall apply.

Regarding particular canal reach/reaches, though the lining be fully completed to acceptable quality levels, such reach/reaches will not qualify for acceptance and

payment till the associated works necessary for safety of lining during rains, such as dowel banks, drainage are also completed along with.

d) The final payment shall be made only after satisfactory core tests acceptable to the Engineer-in-charge as per IS : 456-1978.

15.6.8 CONSTRUCTION JOINTS.

a) The concrete for sides and bed lining should be placed in alternate bays of not more than 3mts. Bays remaining in between may be filled after a gap of at least one day. The joint faces shall be treated with a primer at the rate of one litre per 4 sq.meter of joint surface area.

b) The shuttering should be clean, well oiled, smooth and firmly fixed to the sub grade and concrete near the shuttering properly placed and specially compacted.

c) Faces to be painted with sealing compound.

d) The concrete shall be laid continuously and the construction joints shall be left at the close of the day (or) 45 meters whichever is less vide clause in column 26.3 of IS. : 456/-1978.

15.6.9 MEASUREMENT AND PAYMENT :

All linear measurements shall be in meters, correct to 0.01 meter. Areas shall be computed in square meters, correct to 0.01 square, meters. The thickness of lining shall be determined in relation to final sub grade on which lining is to be laid. The thickness shall be cross checked by (i) Volume of concrete placed and area covered (ii) use of probe when concrete is given and (iii) cores if required. No separate payment will be made. It shall be included in the price Bid quoted in the Bill of Quantities.

15.7 JOINTS:

15.7.1 EXPANSION JOINTS:

a) Scope : Expansion joints of 12 mm. width shall be provided on each template where adjacent panels rest. The joints shall be filled in by 12 mm. thick asphaltic pads, when concrete lining is laid for canals in embankment or in cutting where subgrade does not get physically bonded with the joints. Where concrete lining in physical bond with subgrade such as in case of hard rock reaches, expansion joints need not be provided. The details of joint are shown in the drawings. Sealing compound in the joints shall conform to IS : 5256-1968, including cost and conveyance of all materials, labour charges, all leads, lifts and delifts complete for finished item of work to specifications as per drawings and as directed by the Engineer-in-charge.

b) Expansion joint shall not be provided except where structure intersects the canal lining.

c) In case of sandy soils it is preferable to provided felt/asphalt pad over template and in the vertical joint between the panels to prevent leakage through joint as shown in the drawings.

15.7.2 CONTRACTION JOINTS :

a)Scope : Providing contraction joints in bed, side lining including painting the grove with approved primer and filling grove with hot pour sealing compound of approved quality conforming to IS:5256-1968. including cost and conveyance of all materials, cleaning of groves, placing, dewatering, labour charges, all leads, lifts and delifts complete for finished item of work to specifications as per drawings and as directed by the Engineer-in-charge.

b) Contraction Joints shall be provided at places shown in the drawings or as directed by the Engineer-in-charge in accordance with the provisions laid down.

c) When lining is cast in panels, before laying cement concrete slabs, the top of the sleepers both in bed and side slopes shall be treated with two layers of sealing compound as prescribed in IS : 5256-1968 and as shown in drawings to reduce the leakage across the joints. Slabs shall be laid in alternate compartments with an interval of at least one day for setting and contraction. The faces of the previously placed concrete shall be painted with sealing compound as prescribed in IS : 5256-1968. to ensure that no bonding takes place.

d) The grooves at the joints shall be of the size and shape as prescribed in (b) and filled with hot -applied sealing compound.

e) Filling of the joints with hot- applied sealing compound should be taken up after curing period is over. In the mean time the joints are liable to be filled with earth, which will be difficult to clean. It is, therefore, advisable to fill these joints with coarse sand during the curing period. The sand can be easily blown out from the joints when required.

15.7.2.1 : FILLER :

a) the grooves in canal lining shall be filled with sealing compound conforming to IS : 5256- 1968.

b) The grooves shall be clean and free from foreign substances when sealing compound is filled.

c) Grooves shall not be filled while it is raining or when there is free water in the grooves. The grooves shall be filled as soon as the concrete has become sufficiently stiff to prevent appreciable distortion of groove shape or damage to the concrete.

d) The expansion joint shall be filled with the mixture of following materials with proportion specified against each.

Maxphalt 80-100	30% by volume.
Sand	51% by volume
Cement	17% by volume
Hemp cut to into length	2% by volume
	100% by volume

15.7.2.2 MEASUREMENT AND PAYMENT:

No separate payment will be made. It shall be included in the price Bid quoted in the Bill Quantities.

PART B : MS PIPELINE

MS PIPELINES (Part -1)

The pipelines are used in this Project for Delivery Pipes, Manifolds and Pressure Mains. All pipes should be BIS marked only.

The pipeline shall be divided into sections by valves to avoid the necessity of emptying the whole pipeline in case of repair (in compliance with Clause No.6.16.14 of the CPHEEO manual). Each section being provided with an air valve and scouring facilities. The need for scour should be particularly borne in mind when layout of the pipeline and silting of the valves is finalized, as they cannot always be arranged in the best position due to likely difficulty in disposing of the discharge. They are necessary for scouring the mains and hence should be in proportion to the size of the main.

1. Manufacture and supply of M. S. Pipes :

For Delivery Pipes, Manifolds & Pressure Mains, the thickness of MS pipes shall be calculated as per the design requirements and allowances stated in IS:5822 and in AWWA (American Water Works Association) Manual M11- For steel pipes. The thickness provided shall also be subject to upward revision in surge analysis and as per site conditions requirement. No downward revision is permissible.

1.1. Applicable standards / codes

Following standards shall be referred for manufacture of M. S. pipes using **Structural Steel Sheets**. In all cases, latest revision of the standards / codes shall be referred to. If requirements of this specifications conflict with the requirements of the standards / codes, this specification shall govern.

IS 1916 :	Steel cylinder pipe with concrete lining and coating
IS 5822 :	Laying of electrically welded steel pipes for water supply
IS: 4853 :	Recommended practice for Radiographic inspection of fusion welded butt joints in steel pipes.
IS: 4260 :	Recommended practice for ultrasonic butt weld in ferric steel.
IS: 3600 : (Part-1)	Methods of testing fusion welded joints and weld mains in steel: part 1 cruciform fillet weld tensile test
IS: 4711 :	Sampling of pipe for various tests and criteria for conformity.
IS: 1894 :	Methods of tensile testing of steel tubes.
IS: 10748 :	Hot - Rolled Steel Strip for Welded Tubes and Pipes - Specifications
IS: 1730 :	Dimensions for Steel Plates, Sheets, Strips and Flats for General Engineer-in-Charge Purpose

1.2. Grade of steel

The steel used for manufacture of the pipes (HR coils) shall confirm to IS: 2062, grade-B or IS: 10748, grade - 3 or equivalent ISO. The dimension of HR coils shall conform IS: 2062.The quality of steel, chemical composition and tensile strength of the steel plates shall be as specified in IS: 3589 for steel of grade Fe 410. **tolerance as per IS: 3589 shall be allowed for plate thickness.**

1.3. Electrodes

The electrodes used for welding of steel plates shall confirm to IS: 814

1.4. Certificate for Steel Plates

Steel plates should confirmed to IS: 1730, Dimensions for Steel Plates, Sheets, Strips and Flats for General Engineer-in-Charge Purpose. The test certificate for the plates shall be issued by Plate Manufacturer.

1.5.Standard Length of pipes

The MS pipes shall be manufactured in lengths of 10 to 13m with beveled ends. Length of each pipe shall be measured at diametrically opposite four places and average of the four measured lengths shall be considered for measurements of pipe length.

1.6. Welding process

The pipes shall be manufactured by shop welding from steel plates, butt welded spirally or longitudinally by automatic submerged arc welding process using at least two runs, one of which shall be on the inner side of the pipes. Welding shall be so done that there will be through fusion and complete penetration and shall be free from cracks, oxides, and slag inclusion and gas pockets.

Longitudinally welded pipes shall have circumferential weld at not less than 1.8 m centre to centre. Longitudinal weld shall be staggered. Minimum distance between spiral welds should be 1.5 m.

1.7. Deviation in Length

Finished pipe length shall not deviate from straightness by more than 0.2 percent of the total length.

1.8. Radiographic / Ultrasonic test

Three percent of all seams of pipes, welded in the fabrication shop, shall be radio graphed at the end of pipe (as per IS: 4853) to render visible inspection of any internal defects such as blow holes, slag, inclusion of cracks. If any defects are detected, the metal at the location shall be chipped out and re-welded. In addition to the radiography of the joints, 100 percent testing by ultrasonic equipment (as per IS: 4260) shall also be done for welding tests. Any defects found out shall be rectified free of cost. Welds found deficient in quality shall be removed by chipping or melting and remade as per specifications. Chipping or cutting the weld shall not extend to the base metal.

1.9. Hydraulic Test at Works

Each pipe shall be hydraulically tested at manufacturer's works before applying any coating / lining.

1.10. Allowable tolerance

- Allowable tolerance for out side diameter shall be ± 0.75% of the specified diameter.
- Allowable tolerance for ovality shall not be more than 1% of the specified

diameter.

1.11. Sampling and testing

Sampling and conformity criteria for various tests shall be as given in IS: 4711. The test samples shall be cut from pipes in the final condition of supply. Tests for tensile strength, percentage elongation, guided bend test, shall be carried out and the test values shall be in conformity with those specified in IS: 4711.

1.12. Inspection

The pipes ready in the manufacturer's work yard shall be inspected and tested before dispatch, by the employer and or inspecting agency appointed by the employer. All the tests including hydraulic test shall be carried out on specified number of samples from each lot as specified in IS: 4711, in presence of the inspecting agency. The internal painting shall be applied to the pipes only after the inspecting agency is satisfied regarding the test results, which shall be in conformity with the limits specified in IS: 4711.

2.0 Cement mortar coating (guniting) for external surface of MS pipes

2.1 General

The outside surface of the MS pipes and bends shall be provided with reinforced cement mortar coating for 25mm thickness, 1:3 proportions, applied by mechanical / pneumatic placement.

2.2 Material

Reinforcement

The reinforcement shall consist of BRC fabric of size 100 mm x 100 mm. x 3 mm. Reinforcement shall be free of oil, grease and other contaminants that may reduce the adherence between the coating and reinforcement. The BRC fabric shall be placed in the middle third of the coating. Mortar cover blocks shall be provided to place the BRC fabric properly. Splicing for fabric reinforcement, if required, shall have minimum 100 mm overlap.

2.3 Cement

Portland cement shall confirm to IS 269 / IS 8041 / IS 1489 and IS 8112.

2.4 Sand

Sand shall consist of inert materials having hard, strong, durable uncoated grains confirming to the requirements of IS 2116.

2.5 Water

The water used for guniting shall be clean, colour less, and free from injurious quantities of organic matter, alkali and salt. The maximum water cement ratio shall not exceed 0.45:1.

2.6 Cement mortar

The mortar applied by mechanical or pneumatic process shall consist 3 parts of sand and 1 part of cement by weight. The water in the mixture shall be carefully controlled so that the mortar will not run, sag or segregate. The soluble chloride-ion

(Cl) content of the cement mortar mix shall not exceed 0.15 percent, expressed as a percentage of cement weight. Rebound not exceeding one fourth of the total mix weight may be used as replacement material for fine aggregate only. Rebound not used within 1 hour shall be discarded.

2.7 Surface preparation

The outer surface shall be cleaned for oil grease etc. The dust shall be removed by compressed air or vacuum cleaner before placement of reinforcement. The BRC fabric reinforcement shall then be placed with required cover on the pipe surface.

2.8 Application

The pipe shall be supported on wooden logs at the ends to keep bottom clearance and to facilitate easy rotation while applying the coating. The mortar coating shall be applied in one or more continuous applications for achieving required thickness. If applied in more than one course, the interval between the first and last course shall not be more than 2 hours. The mortar shall be projected at high velocity against the exterior surfaces of the pipe with a pressure of 2.1 to 2.8 kg / cm^2 to produce a hard, tight adhering coating of specified thickness. The coating shall not be applied on ends of pipes for 100 mm length. Ends of coating shall be uniform and square to the longitudinal axis of the pipe. The rebound material unused shall be disposed off within a lead of 50m.

2.9 Placement temperature

The temperature of the cement mortar mix shall not be less than 4^0 C, nor shall the surface temperature of the MS pipe be greater than 35^0 C at the time of placement.

2.10 Curing

After the initial set of the cement mortar coating has taken place, the mortar coating shall be cured by the moist curing method. The coating shall be kept continuously moist by intermittent or continuous spraying of water for a period of at least 7 days.

2.11 Defective coating

If any sand pockets or porous spots occur, they shall be completely cut out and replaced by mechanical / pneumatic placement or hand application of mortar in proportion of 2 parts of sand and 1 part of cement, by weight.

2.12 Coating cracks

Care shall be taken to minimise the occurrence of cracks in the mortar coating. However, hairline cracks need not be repaired. The cracks, if developed, shall be repaired by brushing or wiping of neat cement in to the cracks, or painting of the cracks with epoxy coating or a combination of these methods shall be adopted.

3.0 Transportation of pipes for laying

Handling of the mortar coated pipes while transporting those from guniting yard, for laying and jointing purpose, shall be done very carefully to avoid any damage or development of cracks to the mortar coating. Any damaged portion shall be cutout

and replaced. The pipes shall be laid in the trenches as early as possible after the curing period is over to avoid hair cracks in the coating due to temperature variations.

4.0 Coating for welded joint portion

After the welding and testing of the welded joints of MS pipeline, the BRC fabric reinforcement shall be provided over the joint. Cement mortar used for the joints shall be composed of one part of cement to not more than two parts of sand, by weight, thoroughly mixed with water to the consistency of thick cream. Sand shall be graded confirming to the requirements of ASTM C33, except that 100% shall pass a US standard sieve number 16.

5.0 Testing

5.1 Adsorption test

Water adsorption tests shall be performed on samples of cured cement mortar coating taken from each working shift. The samples shall have been cured in the same manner as the pipe. A test value shall consist of the average of a minimum of three samples taken on the same day from the same work shift. The test method shall be in accordance with ASTM C497, method A. The average adsorption value for any ten consecutive tests from a working shift shall not exceed 10% and no individual sample shall have an adsorption value exceeding 12%.

Tests for each working shift shall be performed on a daily basis until conformance to the adsorption requirements has been established by 10 consecutive test values not exceeding 10%, at which time testing may be performed on a weekly basis for each working shift. Daily testing shall be resumed for each working shift whenever an adsorption test result exceeds 10%. Daily testing shall be maintained until conformance to the adsorption requirements is reestablished by 10 consecutive test values not exceeding 10 percent.

The contractor shall maintain the record of the adsorption tests and shall submit the same to the Engineer-in-Charge weekly.

5.2 Inspection

The tests performed shall be inspected by the Engineer-in-Charge. If any sample fails to meet the requirements, the contractor shall be notified immediately. Material affected by the test r4esults shall be set aside pending final disposition

5.3 Rejection

Material and pipe that are noticed to be defective or that do not confirm to the requirements will be subject to rejection at any time prior to final acceptance of the pipe. Rejected material and pipe shall be removed from the work site within a week after rejection without any liability to the Govt.

6.0 Internal Epoxy coating to MS pipes and specials

6.1 General

Epoxy coating is proposed for internal surface in all conditions and for external surface of the MS pipes laid above ground on pedestals and outer surface of tees, manholes, covers and eccentric reducers.

6.2 Material

The coating shall have one coat of two-part, chemically cured inhibitive Epoxy primer and two coats of a different two-part, chemically cured, solvent free, and spray applied epoxy paint. The coating system shall meet the performance requirements of relevant IS code or AWWA C-210 standard.

6.3 Surface preparation:

6.3.1 Cleaning

Prior to abrasive blast cleaning, the external surface shall be cleaned to remove oil, grease or other foreign matter. Only approved solvents that do not leave a residue shall be used for cleaning.

6.3.2 Abrasive blast cleaning

The surface shall be abrasive blast cleaned to achieve a white metal surface. Prior to blast cleaning, any sharp protuberances, surface laminations, weld spatter, etc shall be removed by through cleaning and grinding. The abrasive used should be capable of producing a minimum profile of 50-75 microns corresponding to "medium" in accordance with BS: 7079 part C4.

7.0 Application of Epoxy coating:

7.1 Atmospheric conditions

Prepared surfaces must be completely cleaned of dust and dirt by brush or vacuum cleaner and shall be thoroughly dry. Coating shall not be applied in the following atmospheric conditions.

- Relative humidity exceeding 85%
- When the surface to be coated is less than 3^0C above the due point
- The surface temperature is less than 7^0C or greater than 50^0C.

7.2 Successive coats

After application of the first coat, the next coat shall be applied within the time limits, surface conditions, and temperature recommended by the manufacturer.

7.3 Coating thickness

Final thickness of the coating shall not be less than 400 micron DFT. The coating shall be applied leaving 15 cm at the edge of pipes / specials for welding of the joint. Coating on this portion shall be applied after welding the joint.

7.4 Preheating

The temperature of mixed coating and that of the pipe at the time of application shall not be lower than 10^0C. Preheating of the coating material, the use of inline heaters to heat the coating material; or heating of the pipe, fittings or specials may be used to

facilitate the application. Heating shall confirm to the recommendations of the coating material manufacturer.

7.5 Touch up and repair procedure

The finished coating shall be inspected for damage or reduced thickness. Any such areas shall be repaired by thoroughly degreasing the surface and abrading using 180 grade abrasive papers, the abraded areas shall extend from the edge of the damage for 50–75 mm on to surrounding sound coating. The prepared surface can then be re-coated.

7.6 Final curing

Sufficient curing period shall be allowed after application of the coating as per standards for the coating to gain required strength. The epoxy applied pipes; specials shall be stored for curing in accordance with the durations given in the specifications.

7.7 Electrical inspection for continuity

After curing, the coating shall be tested for holidays according to the procedures and using the voltage settings. Any holidays indicated by the detector shall be got repaired.

7.8 Coating of joints after welding

The joint portion shall be cleaned thoroughly as stated above and coated in required coats for same thickness i.e. 400 micron DFT.

8. Excavation for Pipe Line Trenches

8.1. Excavation for Pipe Line Trenches

The excavation is carried out by hand or by machine.

8.2. Site Clearance

The pipe line alignment shall be cleared of all bushes, shrubs, roots, grass, weeds and if required trees, coming in the alignment of pipe line in the trench width portion. The rates for excavation shall cover all such site clearance work and no extra payment will be allowed on this account.

8.3. Alignment marking

After the work site is cleared as above, pipe line alignment with required trench width shall be marked on the ground with apex points, curves etc, as shown on the drawings or as directed by the Engineer-in-Charge in charge for the stretch where the work is to be started. The contractor shall provide all labour, survey instruments, and materials such as strings, pegs, nails, bamboos, stones, mortar, concrete etc. required for setting out and establishment of bench marks. The contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as they are required for the work in the opinion of the Engineer-in-Charge.

8.4. Working survey

Working survey of the pipeline alignment shall be carried out by the contractor before start of the excavation work. The contractor shall provide all the instruments such as leveling instruments, steel tape, ranging rods, strings, pegs etc. for carrying out the survey. Based on the working survey, the alignments, L-section (depth of laying), grade, and location of specials, valves and chambers shall be finalized and got approved from the competent authority. The gradient and alignment shall be such that minimum horizontal and vertical bends shall be required.

8.5Use of Machinery:

All excavations shall be carried out by mechanical equipments / machinery unless, in the opinion of the Engineer-in-Charge, the work involved and time schedule permit manual excavation.

8.6Trench Width and Depth:

All buried pipelines shall be minimum 1.2 meter below ground level.

The trench width for respective pipe diameters permissible as required under respective IS code for Pipeline laying and installation.

The trench width shall be constant through out the trench depth, which will provide a clearance of about 0.30 m on either side of the pipe line.

The contractor may, for the facility of work or similar other reasons, excavate and also backfill later, if so approved by the Engineer-in-Charges, at his own cost, outside the allowable trench width specified above. Should any excavation be taken below the specified trench bottom, contractor shall fill it up to required level, at his own cost, with the same material available at the trench bottom including watering and compaction.

The excavation shall be taken down to such depths as shown in drawings. Excavation for extra depth equal to the thickness of proposed pipe bedding shall be done below pipe soffit level for providing bedding below pipe line. The trench bottom shall be excavated to proper grade as shown on drawings. The contractor shall provide site rails and leveling instruments required for checking the grade during excavation, bottom bedding and pipe laying Projections in rock excavation shall be removed by chipping.

The contractor shall carryout extra excavation at the pipeline joints to be welded, as required (minimum 0.6 m deep and 0.9 m lengthwise, all around the pipe), for facilitating proper welding of the bottom joint from out side.

The work of trench excavation should be commensurate with laying and jointing of the pipe line. It should not be dug in advance for a length greater than 500 m ahead of work of laying and jointing of pipeline unless otherwise permitted by the Engineer-in-Charge.

The minimum cover on pipe is to be maintained 1.2 meter. However the cover on pipe may be modified to suite gradients and site conditions as per direction of Engineer-in-Charge.

8.7. Barricading and Guarding:

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of work, till filling of the trenches after pipes are laid and jointed. The lighting, barricading, guarding of the trenches and the maintenance of watchman shall be done by the contractor at his cost.

All precautions shall be taken during excavation and laying operation to guard against possible damage to any existing structures, under ground cables, pipe lines of water, gas, sewage etc. Any damage done to such properties will have to be repaired / rectified by the contractor at his cost. The Contractor has to ensure the following:

- safety protections as mentioned above have to be incorporated in the work process
- hindrances to the public have to be minimized
- the trench must not be eroded before the pipes are laid
- the trench must not be filled with water when the pipes are laid
- the trench must not be refilled before laying of the pipes

The bed for the laying of the pipes has to be prepared according to the L-Section immediately before laying of the pipes.

8.8. Reuse of surface material

All surface materials, which in the opinion of the Engineer-in-Charge, are suitable for reuse in restoring the surface shall be kept separate from the general excavation material, as directed by the Engineer-in-Charge.

8.9. Stacking of excavated material

All excavated materials shall be stacked in such a manner that it does not endanger the work and avoids obstructing foot paths and roads. Hydrants under pressure, surface boxes, fire and other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clean or other necessary provisions made for street drainage and natural water courses shall not be obstructed. All the excavated material shall be the property of the Employer and shall be stacked or disposed off as directed by the Engineer-in-Charge.

8.10. Maintenance of traffic

The work of excavation and pipe laying shall be carried in such a manner that it causes the least interruption to traffic and the road / street may be closed in such a manner that it causes the least interruption to the traffic. Where it is necessary for traffic to cross open trenches, suitable bridging arrangement shall be provided. When the street is closed for traffic, suitable signs indicating that street is closed shall be placed and necessary detour signs for proper maintenance of traffic shall be provided.

8.11. Structure protection

Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress

of work shall be furnished under the direction of the Engineer-in-Charge. The structures which have been disturbed shall be restored upon completion of work.

8.12. Protection of property

Trees, shrubbery fences, poles and all other property shall be protected unless their removal is allowed by the Engineer-in-Charge. When it is necessary to cut roots and tree branches, such cutting shall be done under the supervision and direction of the Engineer-in-Charge.

8.13. Avoidance of existing services

As far as possible, the pipeline shall be laid below existing services, such as water and gas pipes, cables, cable ducts and drains but not below sewers. Excavation of the trenches shall be carried out to the required depth accordingly. If it is unavoidable, the pipeline shall be suitably protected and lesser trench depth in such cases can be allowed. A minimum clearance of 150 mm shall be provided between the pipeline and such other services. When thrust or auger boring is proposed for laying pipeline across roads, railway or other utilities, larger clearance as required shall be provided. Adequate arrangements shall be made to protect and support the other services during excavation and pipe laying operations. The work shall be so carried out as not to obstruct access to the other services for inspection, repair and replacement. When such utilities are met with during excavation, the authority concerned shall be intimated and arrangements made to support the utilities in consultation with them.

8.14. Bailing out of Water

During the excavation if subsoil water is met with, contractor shall provide necessary equipment and labour for dewatering the trenches. If pumping out subsoil water is found necessary, contractor shall provide sufficient number of pumps for the same. The tendered rate shall cover all costs for bailing out of water including hire charges of pumps, cost of diesel and labour etc and hence, no extra payment shall be allowed.

8.15. Disposal of loose boulders etc

All loose boulders, semi detached rocks, (along with earthy stuff which might move therewith), not directly in the excavation but close to the area to be excavated, as to be liable, in the opinion of the Engineer-in-Charge, to fall or other wise endanger the workman equipments, or the work etc, shall be stripped off and removed away form the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe.

8.16. Disposal of Excavated Material

All the excavated surplus material shall be disposed off on muck area with due consultation of Engineer in Charge.

9.Moorum / Sand Bedding below Pipeline

In case of hard rock before lowering of the MS pipes in trenches, a layer of selected moorum, shall be provided below the MS pipe line to act as bedding. The bedding shall be compacted properly including required watering and the thickness of

well compacted layer shall not be less than 150 mm. The bedding shall be provided for full trench width with proper grade as shown on drawings.

10.Refilling the trenches

10.1. Use of selected excavated material

Filling of excavated material in trenches shall be commenced as soon as the joints of pipes and specials have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes and the outer coating.

Selected surplus spoils from excavated material shall be used as backfill. Fill material shall be free from clods, salts, sulphate, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixture used for filling.

10.2. Back Filling

All excavations shall be backfilled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Engineer-in-Charge in Charge, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof, and the manner of depositing and compacting shall be subject to the approval of the Engineer-in-Charge in Charge, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

The back filled layers shall be wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the Contractor at his expense.

The Contractor shall at his own expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.

On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The Contractor shall not use backfilling for disposal as refuse or unsuitable soil.

10.4. Fillings of the trench excavated in rock

In case of excavation of trenches in rock, the filling up to a level of 30 cm above the top of the pipe shall be done with fine materials, such as soft soil, murrum etc. The filling up of the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 15 cm, whereas the filing above the centre line of the pipe shall be done by hand compaction or mechanical means in layers not exceeding 15 cm. The filling from a level of 30 cm above the top of the pipe to the top of the

trench shall be done by mechanical methods with broken rock filing of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

10.5. Consolidation

The consolidation of the filled material shall be done to attain not less than 90 percent of the maximum dry density. The density of the filled and compacted material shall be tested regularly and record maintained accordingly.

11. Lowering, laying and jointing of MS pipes

11.1. Standards

Except as otherwise specified in this technical specification, the Indian Standards and Codes of Practice in their latest version, National Building code, I & CAD specification of the state of Telangana and Manual of water supply of GOI shall be adhered to for the, handling, laying, installation, and site testing of all material and works.

(q) 11.2 Tools and equipment

The contractor has to provide all the tools and equipment required for the timely, efficient and professional implementation of the work as specified in the various sections of the contract and as specified by the instructions of manufacturers of the pipes and other material to be handled under this contract. On demand he shall provide to the Engineer-in-Charge a detailed list of tools and equipment available. If in the opinion of the Engineer-in-Charge the progress or the quality of the work cannot be guaranteed by the available quantity and type of tools and equipment the contractor has to provide additional ones to the satisfaction of the Engineer-in-Charge. The Contractor will always have a leveling instrument on site.

11.3 Handling, transportation of pipes and specials

The Contractor has to transport the pipes and other materials from manufacturer or site store yard / guniting yard to the site of laying as indicated by the Engineer-in-Charge in Charge. Pipes should be handled with care to avoid damage to the surface and the socket and spigot ends, deformation or bending. Pipes shall not be dragged along the ground or the loading bed of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects. The pipes shall rest uniformly on the vehicle bed in their entire length during transportation. Pipes shall be loaded and unloaded by suitable mechanical means without causing any damage to the stacked pipes.

The transportation and handling of pipes shall be made as per IS 12288 and IS 5822. Handling instructions of the manufacturers of the pipes shall be followed. All precautions set out shall be taken to prevent damage to the protective coating, damage of the jointing surfaces or the ends of the pipes.

Whatever method and means of transportation is used, it is essential that the pipes are carefully placed and firmly secured against uncontrolled movement during transportation to the satisfaction of Engineer-in-Charge in charge.

(r)

Cranes or chain shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used. Where using crane hooks at sockets and spigot ends, hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining / coating. Damage to lining / coating must be repaired before pipe laying according to the specifications mentioned elsewhere and as per instructions of the Engineer-in-Charge in charge. Pipes shall not be thrown directly on the ground.

(s)

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently with safety. The pipes should be lifted smoothly without any jerking motion and pipe movement shall be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.

(t)

Rolling or dragging pipes along the ground or over other pipes already stacked shall be avoided.

11.4 Stringing of pipes along the alignment

The pipes shall be laid out properly along the proposed alignment in a manner that they do not create any significant hindrance to the public and that they are not damaged. Stringing of the pipes end to end along the working width should be done in such a manner that the least interference is caused in the land crossed. Gaps should be left at intervals to permit the passing of equipment across the working area. Pipes shall be laid out that they remain safe where placed and that no damage can occur to the pipes and the coating until incorporated in the pipeline. If necessary, pipes shall be wedged to prevent accidental movement. Precautions shall be taken to prevent excessive soil, mud etc. entering the pipe.

(u) 11.5 Laying and jointing of pipes- following Specifications are detailed herein for laying

(v) and jointing

(w) 11.5.1. Laying of pipes below ground - guniting as per IS specifications

(x)

11.5.1.1. General

After the trench is made ready with bedding, and after the jointing pits are excavated at the joint position, the gunited and lined pipes shall be lowered in the trenches.

The MS pipe ends shall be cleaned with special care to ensure that they are free from dirt and unwarranted projections. The whole of the pipes shall be placed in position singly and shall be laid true to profile and direction of slope indicated on

longitudinal sections. The pipes shall be laid without deflection in a straight alignment between
bends and between high and low points. The alignment and levels shall be checked by the contractor with suitable equipment.

Before pipes are jointed they shall be thoroughly cleaned of all earth lumps, stones, or any other objects that may have entered the interior of the pipes.

Pipes and the related specials shall be laid according to the instructions of the manufacturers and using the tools recommended by them.

Cutting of pipes shall be reduced to a minimum required to conform to the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer without damage to the external coating and internal lining. The spigot end has to be beveled again at the same angle as the original beveled end. While assembling the pipes the ends shall be brought close enough to leave a uniform gap not exceeding 3 mm. Marginal cutting shall be done if found necessary, for which no extra payment shall be admissible. There shall be no lateral displacement between pipe faces to be jointed. After the pipes are properly assembled and checked for the correct line and level, tack welding for the pipe joint shall be done. Final welding of the joint from inside and outside shall be done thereafter.

11.5.1.2. Straps

Whenever the pipe laying work proceeds from two ends and if gap remained between two faces is less than 30 cm, such gap shall be bridged by providing a strap. Strap shall also be provided during fixing of expansion joint for above ground pipeline. Such strap shall be fabricated on site by cutting a piece from the pipe. This piece shall be split longitudinally and stepped over the gap. A minimum overlap of 2 times of the thickness shall be provided on both the pipe ends to be connected. The strap shall be welded with pipe ends with required number of fillet welds from inside and outside. The gap between ends of the strap shall be butt welded longitudinally.

11.5.1.3. Distance piece

Distance piece shall be provided when the gap between pipe faces to be jointed is more than 30 cm. Distance pieces shall be cut from pipe pieces for required length either on site or in factory. Payment shall be as per the laying and jointing of pipeline item.

All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. The Contractor has to ensure that the specials and accessories are ready in time to be installed together with the pipes.

At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt or other foreign matter by means of approved plugs or end caps.

When pipe laying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water and dirt into the line. No pipe shall be laid in wet trench conditions that preclude proper bedding, or when, in the opinion of the Engineer-in-Charge, the trench conditions or the weather are unsuitable for proper installation. The pipe line laid should be absolutely straight unless planned otherwise. The accuracy of alignment should be tested before starting refilling with the help of stretching a string between two ends of the straight stretch of pipes to rectify possible small kinks in laying.

11.5.2. Laying of pipes above ground

11.5.2.1 General

Above ground pipe line shall have epoxy coating on inner and outer surfaces.

Laying of pipeline shall be started only after sufficient number of chairs / pedestals have been casted as per design which shelled not be less than 0.6 m in width to required level and have achieved their final strength including fixing of the bearing plates and roller bearings.

The contractor shall lay the pipeline to the exact line and level as shown on the drawings, or as directed by the Engineer-in-Charge.

11.5.2.2 Laying procedure

The pipe laying shall start from the successive fixity points towards expansion joint, if proposed in that stretch. Depending upon the distance between the successive chairs, and the length of the pipes fabricated, two pieces may be welded on site before laying so that after laying the pipe rests on next chair and overhangs for at least half the length of pipe.

Normally not more than one pipe shall be aligned, tacked and kept in position on the chairs at a time. During assembly, the pipes shall be additionally supported on adequate wooden sleepers or scaffolding as necessary, kept between the chairs / pedestals. While assembling the pipes, the ends shall be brought to leave a uniform gap not exceeding 3 mm. The ends shall be tack welded to align the pipe properly.

Full welding of the circumferential joint shall be done only after the Engineer-in-Charge has checked the correctness of the alignment and level. Further laying of pipes shall not be undertaken unless full welding of the circumferential joints of the piped laid earlier is completed. Expansion joint shall be fixed at the location shown on drawing or as directed by the Engineer-in-Charge.

11.6. Welding the joints

11.6.1. General

Before aligning, assembling and welding, the pipe faces shall be cleaned by scrapping with wire brushes or by any other approved method.

Welding of pipes in field shall confirm to IS: 816 (code of practice for use of metal arc welding for general construction in mild steel). Electrodes used for welding shall

comply with IS:814. In case of variation, specifications hereunder shall have precedence.

Welders shall be qualified and well experienced and shall be approved by the Engineer-in-Charge. Contractor shall remove such of the welders from the job whose work is not satisfactory.

The contractor shall keep record of the welding for each circumferential joint. It shall contain the name of the welder, date of completion of the welding runs internal as well as external.

11.6.2. Gouging and chipping

MS pipes to be jointed are large in diameter and hence the joints shall be welded with required numbers of runs from one side and a sealing run from other side. External sealing run shall be done only after internal welding is completed. Before starting the external welding, the weld material in the joint shall be cleaned by chipping out loose scales. Gauging shall be done before rectification of any defective welding wherever necessary and as directed by Engineer-in-Charge.

Gauging and chipping shall not be paid separately and the rate for welding shall be deemed to include the cost of gauging and chipping.

11.6.3. Electrodes

Welding electrodes shall confirm to IS: 814. The contractor shall use electrodes depending on thickness of the plates to be welded and the type of joint. The contractor shall use standard current and AC voltage required for the machine as per manufacturer's directions.

11.6.4. Type of joints

The circumferential joints of the pipes shall have butt welded with required number of runs externally and internally.

All the fillet welds / lap welds shall have throat thickness not less than 0.8 times the thickness of the pipe to be welded.

11.7. Testing of welded joints

Welded joints shall be tested in accordance with the procedure laid down in IS: 3600, Method of testing fusion welded joints and weld metals in steel.

At least one test specimen shall be taken out for testing for every 50 field joints. Test pieces shall be taken out from the places pointed out by the Engineer-in-Charge. These shall be machined and tested as early as possible.

The shape of the test pieces removed for testing shall be such that it shall give the specimen of the required dimensions with the weld in the middle of the specimen. It must ensure good butt weld.

11.7.1. Tensile test

The test specimen taken perpendicularly across the weld shall be shaped in accordance with IS: 3600 (part 3). The tension test specimen shall be machined. The protruding welded portion from inside as well as outside shall be removed by machining before the specimen is tested. The specimen shall be tested in tension in accordance with IS: 1608

If the specimen shows defective machining or develops flaws not associated with welding, it shall be discarded and another specimen substituted. The welded joint shall show strength not less than the minimum tensile strength for the plate in accordance with IS: 226.

11.7.2. Bend test

Bend test specimen shall also be prepared in the same fashion as the tensile test specimen. The specimen shall be bent cold 180^0 around a pin that has a diameter equal to 4 ½ time the plate thickness, without developing cracks. For this test, face representing inside of the pipe shall be placed next to the pin.

11.7.3. Tree-panned plugs

Tree-panned plugs shall be taken out from any welded portion as pointed out by the Engineer-in-Charge. These plugs shall not show any defects in welding such as inclusion of slag, blow holes, cavities, etc. The plug shall be 12 mm in diameter and shall be taken out by means of suitable electrically operated machine. Such holes in the pipe shall either be filled back by inserting a steel stud and welding around or threading the hole and providing suitable GI plug. This test shall be done if considered necessary by the Engineer-in-Charge.

11.7.4. Non-destructive tests

Non-destructive testing of the completed weld shall be carried out on pipelines by radiographic method as specified under IS: 4853 or ultrasonic method as per IS: 4260. Non-destructive test for every 50 joints shall be carried out.

11.8. Procedure on failure of test specimen

If the test specimen fails in either tensile or bent test or in both, two additional test specimens shall be taken out from the section and shall be tested again for both the tests. If any one of them fails, extensive gouging and repairing shall be carried out for the welded joints in that section to the full satisfaction of the Engineer-in-Charge in charge. However, if both the samples give satisfactory results, the joint from which the original sample was taken and had failed, shall be repaired at contractor's cost.

Welder who has done the welding of the joint that has failed shall be solely held responsible for bad workmanship and failure. Since all other factors like electrodes, current, arc voltage, etc are already controlled; negligence on the part of the welder only is responsible for such failure. For first such failure, the welder shall be warned and if the failure is repeated, he shall be removed from the job.

11.9Anchoring of the pipeline:

Reinforced concrete thrust blocks shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per design done by ENGINEER-IN-CHARGE considering the highest pressure during operation or testing of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

12. Field Hydraulic testing of the pipelines

12.1 Sectional tests

After laying and jointing the pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections approved by the Engineer-in-Charge in Charge. The length of the sections depends on the topographical conditions. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber).At the beginning, the Contractor shall test stretches for suitable lengths to suit the site requirements. The hydraulic testing shall have to be commenced immediately after laying and jointing.

The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases: preparation, pre-test/saturation and test, immediately following the pre-test. Generally, the following steps are required which shall be monitored and recorded in a test protocol.

- Complete setting of the thrust blocks.
- Partial backfilling and compaction to hold the pipes in position while leaving the joints exposed for leakage control
- Opening of all intermediate valves (if any)
- Fixing the end pieces for tests and after temporarily anchoring them against the soil (not against the preceding pipe stretch)
- At the lower end with a precision pressure gauge and the connection to the reciprocating pump for establishing the test pressure
- At the higher end with a valve for air outlet
- If the pressure gauge cannot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly
- Slowly filling the pipe from the lowest point(s).
- The water for this purpose shall be reasonably clear and free of solids and suspended matter
- Complete removal of air through air valves along the line.
- Closing all air valves and scour valves.
- Slowly raising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring.
- Keeping the pipeline under pressure for the duration of the pre-test / saturation of the lining by adding make-up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.
- Start the test by maintaining the test pressure at the desired level by adding more make-up water; record the water added carefully and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.

The pipeline stretch will pass the test if the water added during the test period is not exceeding the admissible limits. No section of the pipe work shall be accepted by the Engineer-in-Charge in Charge until all requirements of the test have been obtained.

12.2. Hydraulic test for MS pipes

12.2.1 Field test pressure

The sections of MS Storm Water Pumping mains shall be tested for the pressures as worked out in detailed designed.

12.2.2 Test requirement

The quantity of water added in order to re-establish the test pressure should not exceed 0.10 liter per mm of pipe diameter per km of pipeline per day for each 30 m head of pressure applied.

All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount calculated as above.

12.3 Failure to pass the test

All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test shall have been obtained. Any work which fails or is proved by test to be unsatisfactory in any way shall be redone by the Contractor.

12.4 Back filling

Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline shall be completed.

12.5. Flushing and disinfecting of pipelines

After testing and commissioning the contractor shall flush the pipes with a velocity not less than 1 m/s or as approved by the Engineer-in-Charge in Charge. Disinfection of drinking water pipelines should be done by Contractor.

MS PIPES (Part 2 - SUPPLY OF MS PIPES AND SPECIALS, VALVES, LAYING AND JOINTING OF PIPELINES)

1.1General

1.1.1Standards

Except as otherwise specified elsewhere in this tender document, the Indian/International Standards and Codes of Practice in their latest version shall be adhered to for the design manufacturing, inspection, factory testing, packing, handling and transportation of product wherever applicable. Should any product be offered conforming to other standards, the equipment or products shall be equal to or superior to those specified and the documentary confirmation shall be submitted for the prior approval of the Engineer.

This specification requires a reference to the following standard specifications:

IS: 2062	Specification for steel for general structural purposes
IS: 808	Specification for dimensions for hot rolled steel beam, column, channel and angle sections
IS: 814	Specification for covered Electrodes for manual metal arc welding of carbon and carbon manganese steel.
IS: 3613	Acceptance tests for wire flux combination for submerged arc welding.
IS: 7280	Specification for bare wire electrodes for submerged arc welding of structural steel
IS: 1367	Technical supply conditions for threaded steel fasteners
IS: 2016	Specification for plain washers.
IS: 2074	Specification for ready mixed paint air drying, red oxide zinc chrome and priming
IS: 102	Ready mixed paint, brushing, red lead, non-setting, Priming.
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 432 (Part-I)	Specification for mild steel & medium tensile steel bars and hard drawn steel wire for concrete reinforcement: Mild steel and medium tensile steel bars
IS: 432 (Part-II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement: Hard drawn steel wire
IS: 269	Specification for 33 grade ordinary Portland cement
IS: 8041	Specification for rapid hardening Portland cement.
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 12330	Specification for sulphate resisting Portland cement
IS: 456	Code of practice for plain and reinforced concrete
IS: 800	Code of practice for general construction in steel
IS: 816	Code of practice for use of metal arc welding for general construction in mild steel
IS: 4353	Recommendation for submerged arc welding of mild steel & low allow steels
IS: 817	Code of practice for training and testing of metal arc welders.
IS: 1182	Recommended practice for radiographic examination of fusion-welded butt joints in steel plates.
IS: 2595	Code of practice for radiographic testing.
IS: 3658	Code of practice for liquid penetrant flaw detection.
IS: 5334	Code of practice for magnetic particle flaw detection of welds.
IS: 3600	Code of procedure for testing of fusion welded joints and weld metal in steel
IS: 4853	Recommended practice for radiographic examination of fusion welded circumferential joints in steel pipes.

IS: 3589	Specification for seamless or electrically welded steel pipes for water gas and sewage (168.3 to 2032mm outside diameter).
IS 5822	Laying of electrically welded steel pipes for water supply.
IS: 6631	Steel pipes for hydraulic purposes
IS: 7343	Code of practice for ultrasonic testing of ferrous welded pipes and tubular products.
IS: 2598	Safety code for industrial radiographic practice
IS: 5822	Code of practice for laying of welded steel pipes for water supply
BS EN 499	Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non Allow and Fine Grain Steel Classification
AWS:A-5.1	Specification for Mild steel Covered Arc Welding Electrodes
AWS:A-5.17	Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding
ASTM E 94	Guide for Radiographic Testing
ASTM E 709	Guide for Magnetic Particle Examination
ASTM E 165	Test Method for Liquid Penetrant Examination
IS: 5504 & IS: 3589	Code for SW pipes
IS: 10748	Requirement for Weldable Hot Rolled Carbon Steel Strip in Coils

CPHEEO Manual on Water Supply and Treatment, II edition, Ministry of Urban Development, New Delhi – May 1999

MS PIPES (Part 3 APPURTENANCES AND MISCELLANEOUS ITEMS)

1. Double Flanged Valves

1.1. Sluice Valves

1.1.1 General

The sluice valves shall confirm to IS: 14846. Double flanged short body, Gland less (stem sealing rings) type Sluice valves with appropriate pressure rating.

The material to be supplied under this sub-section shall include, but not be limited to, the following: All necessary fittings including bolts, nuts, gaskets, backing rings, counter flanges, jointing material, strainers etc. shall be supplied as required. The entire Gland less (stem sealing rings) sluice valve shall be provided with ball thrust bearing and spur gear **arrangement.**

1.1.2 Scope

The Gland less (stem sealing rings) sluice valves shall be with non rising stem type. The valves will be used for water supply on line installations in upright positions, with double flange, and cap or hand wheel for manual operation. The valves shall be suitable for continuous use at their PN rating within the temperature range of -10^0 C to 65^0 C.

1.1.3 Nominal pressure and dimensions

The working pressure on the valves shall be appropriate to the working conditions and approved by the Employer. The flanges and their dimensions of drilling shall be in accordance with IS: 1538 (part-I to XXII).

1.1.4 Material

The makes given are acceptable makes however the material for different component parts of sluice valve shall conform to the requirements given below:

No.	Component	Material	Ref. to IS	Grade / Designation
1	Body, bonnet, dome, stool cover, wedge, stuffing box, gland, thrust plate, hand wheel and cap.	S. G. iron	1865	Gr.400/ 12
2	Stem	Stainless steel	6603	$12C_r$ 13 $04C_r$ 18Ni 10 $04C_r$ 17Ni 12 MO 2
3.	Wedge, nut, shoe	Leaded tin bronze	318	LTB-2
4	Body seat	Leaded tin	318	LTB – 2

	ring, wedge facing ring and bushes	bronze		
5	Bolt	Carbon steel	1363 (Part 1)	Class 4.6
6	Nut	Carbon steel	1363 (Part 3)	Class 4
7	Gasket	EPDM Rubber	11855	-
8	Gland packing	Stem Sealing Ring	5414	Nil
9	Gear	Spheroidal graphite iron	1865	G_r 500 / 7
10	Gear housing	S.G. iron	1865	Gr.400/12
11	Pinion and pinion shaft	Wrought carbon steel	1570 (Part 3)	C55Mn75

1.1.5. Marking, testing and inspection

The standard marking and packing of the valves shall be done as per Clause 11 and 13of IS: 14846. The direction of rotation for OPEN, CLOSE position shall be marked on the hand wheel and on the bonnet of the valve.

Hydraulic testing of each sluice valve shall be done for close end test in accordance with IS: 14846 Annex B, to the test pressure and test duration as specified in table 5 and 6 of the IS.

All the valves shall be inspected for flaw detection test in accordance with IS: 14846, clause 10.2.The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.1.6 Manufacturer's Test certificate

The manufacturer shall provide a test certificate confirming that all the valves have been tested in accordance with IS: 14846 and stating the pressures and medium used in the test.

1.1.7. Inspection

The inspection and testing of the sample valves from a lot will be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop, before application of any paint. All the tests as required as per the IS: 14846 shall be carried out on samples from each lot (Number of samples from a lot shall be as per the relevant IS for sampling and testing), in presence of the inspecting

agency. The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be paid by the contractor to the inspecting agency.

1.1.8. Acceptable makes for the valves

Acceptable makes for the sluice valves shall be as approved by Chief engineer.

1.1.9. Installation

The installation of the sluice valves shall be done at the locations shown on L-sections of the pumping main as washout valves and isolating valves for air valves. The job covers supply of the valves at work site with cost of all the required material and all types of taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job also covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section

1.2. Butterfly valves

1.2.1. General

The Butterfly valves shall confirm to IS: 13095. Double flanged short body butterfly valves of required nominal diameter and pressure rating shall be supplied. The material to be supplied shall include, but not be limited to, that as shown in the table given below. All necessary fittings including bolts, nuts, gaskets, jointing material etc. shall be supplied as required.

1.2.2. Scope

The butterfly valves shall be with disc and shaft and shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The valves shall have no visible leakage past the disc in closed position under test conditions. The shaft may be of one piece design or in two pieces separately attached to the disc. The valves will be used for water supply on line installations in upright positions with manual operation. The valves shall be suitable for continuous use at their pressure rating within the temperature range of -10^0C to 65^0C.

1.2.3. Nominal pressure and dimensions

The working pressure on the valves shall be appropriate to the working conditions and approved by the Employer. The flanges and their dimensions of drilling shall be in accordance with IS: 1538 (part-I to XXII).

1.2.4. Material

The makes given are acceptable makes however the material for different component parts of butterfly valves shall conform to the requirements given below:

S. No.	Component	Material	Ref. to IS	Grade
1	Body	Sphéroïdal graphite	1865	Gr. 400/12

		Iron. / Ductile Iron.		
2	Disc	Sphéroïdal graphite Iron. / Ductile Iron.	1865	Gr. 400/12
3	Shaft	Stainless steel	6603	-
4	Seating ring / Seal retaining ring	Integral Nicol Crominium Welding	-	-
5	Seat	EPDM Rubber	-	-
6	Shaft bearing seals	Bronze / brass bearing with 'O' rings	-	-
7	Internal fastners	Stainless steel	Manufacturer's standard	Suitable for duty
8	External bolting	Carbon steel; tensile strength 390 Mpa	-	-

1.2.5 Operation

All valves shall be capable of being operated at a differential pressure across the disc as marked on the valves. Leaver, worm gear / traveling nut type or any other suitable type of operator can be used.

Manually operated valves shall be closed by turning hand wheel or leaver in a clockwise direction when facing the hand wheel or leaver. The design of leaver when fitted shall be such that the leaver may only be assembled to the valve so that it is parallel to the direction of flow when the valve is open.

All traveling nut operators shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

All gear / traveling nut operators shall be self locking type. All leaver operated valves shall be capable of being locked at at-least three intermediate positions. The operating hand wheels shall be marked 'CLOSE' or 'SHUT' to indicate the direction of closure. The operator shall be provided with arrangement to indicate disc position.

1.2.6. Testing

All valves shall be hydraulically tested by the manufacturer before dispatch. The pressure shall be applied without any significant hydraulic shock. Testing shall be carried out before application of paint or other similar treatment.

1.2.6.1. Body test

The body ends shall be blanked. The valve disc shall be in slightly open position and the pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of test shall be 5 minutes for 1600 mm diameter valve.

1.2.6.2. Seat test

Seat test shall be carried in accordance with clause 17.3 of IS: 13095 for 3 minute duration.

1.2.6.3. Disc strength test

The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure. With disc in closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per table 3 of the IS: 13095. There shall be no damage to the valve disc or any part of the valve, or disc shall not be permanently deformed.

1.2.7. Manufacturer's certificate

The manufacture shall provide a test certificate confirming that all the valves have been tested in accordance with IS: 13095.

1.2.8. Inspection

The inspection and testing of the sample butterfly valves shall be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop before application of any paint. All the tests as required as per the IS: 13095 shall be conducted in presence of the inspecting agency on the sample valves from the lot (Number of valves to be tested from a lot shall be as per the relevant IS for sampling and testing). The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be paid by the contractor to the inspecting agency.

1.2.9. Marking

Marking shall be cast integral on the body or on a plate securely attached to the body. Marking shall be as specified under clause 21 of IS: 13095.

The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.2.10. Acceptable makes for the valves

Acceptable makes for the double flanged butterfly valves shall be as approved by the Chief Engineer.

1.2.11. Installation

The installation of the butterfly valves shall be done at the locations shown on L-sections of the pumping main as online valves. The job covers supply of the valves at work site including all type of taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valve after installation for the specified test pressure for the respective pipeline section.

1.3. Kinetic Air valves

1.3.1. General

Kinetic air valves are required with pressure rating appropriate for the working conditions and approved by the Employer, confirming to IS: 14845.

1.3.2. Scope and general design features

The air valves shall be capable of exhausting air from pipeline automatically when being filled. Air shall be released at sufficiently higher rate so that there shall be no restriction for the inflow rate. Similarly, the valves shall be capable of ventilating pipeline automatically when being emptied. The air inflow rate should be sufficiently high to avoid development of vacuum in the pipeline.

The design shall be such that, higher the rate of flow the greater the resultant down thrust, keeping the ball 'glued' to its seat until the last drop of air is expelled from the pipe system.

Each air valve shall be provided with an isolating sluice valve with flanged end connection. The possible air velocity (inflow and outflow) must be at least 10 m/s.

1.3.3. Construction features

The flow of air should be as unobstructed as possible. The low pressure orifice shall be in the same axis as the main discharge / incoming air flow and must have a diameter sufficiently large. The valve body shall be designed in such a way that the turbulent air at the time of filling of pipeline shall not circulate and cause the ball to be caught in the discharging air stream and blowing the valve shut permanently. The cone angle of the low pressure (large orifice) chamber shall be such that even at a critical velocity of air escaping at 344 m / sec the total impact force on the vulcanite covered ball is less than the suction force on the annular area between the ball and cone. The annulus around the low pressure vulcanite covered ball is to be generously proportioned for discharge of air under various differential pressures. Normal range of cone angle is 45^0 to 60^0.

The orifice shall be carefully profiled to allow the requisite flow of air under varying differential pressures. It shall be in molded synthetic rubber such that even after

extended contact the, vulcanite covered ball does not stick to it, when the line pressure becomes zero.

The high pressure chamber having small orifice shall be so designed that the orifice is effectively sealed in working condition. The orifice shall be profiled in such a manner that the rubber covered ball is not damaged even after extended contact. There should be machined guide in the chamber which ensures that the ball travels vertically and makes contact with the nipple and seals off the orifice without fail. The orifice size shall

Not be less than 2.5 mm and tapering to 10 mm suitable to release accumulated air within the pipeline. High pressure orifice may be fitted from bottom side of the cover.

1.3.4. Material

The makes given are acceptable makes however the material for different components parts of the air valve shall conform to the requirements given below:

S. No.	Component	Material	Reference to IS No.	Grade of designation
1	Body, cover, valve disc, stuffing box, valve guide, cowl, gland, cap, joint support ring	S. G. iron / Ductile iron	1865	Gr.400/ 12
2	Low Pressure seat ring and face ring	Natural rubber	11855	
3	High pressure orifice	Leaded tin bronze	318	LTB-2
4	Bolts	Carbon steel	1363	Class 4, 6
5	Nuts	Carbon steel	1363	Class 4
6	Gasket	Rubber	638	Type B
7	Float	Stainless steel	-	-
8	Float guide	Leaded tin bronze	318	LTB-2

1.3.5. Floats

Minimum float diameters for kinetic air valves shall be as indicated in table 3 of IS 14845. The inner core of the floats shall be made from stainless steel having sufficient bearing strength and equivalent specific gravity.

1.3.6. Testing

Testing of all the air valves shall be carried out in the suppliers work shop as per IS:14845.

Following tests shall be carried for each valve.

- Function and performance test as per clause 12.4.1
- High pressure orifice test as per clause 12.4.2
- Low pressure orifice test as per clause 12.4.3
- Body test as per clause 12.4.4

The performance of the valve for the above mentioned tests shall be as specified under clause 12.1, 12.2 and 12.3 of IS 14845.

1.3.7. Manufacturer's Test certificate

The manufacturer shall provide a test certificate confirming that all the air valves have been tested in accordance with the relevant standards and performance of the test results observed.

1.3.8. Inspection

The inspection and testing of the sample air valves shall be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop before application of any paint. All the tests as required as per IS 14845 shall be conducted in presence of the inspecting agency on the sample valves from the lot (Number of valves to be tested from a lot shall be as per the relevant IS for sampling and testing). The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be paid by the contractor to the inspecting agency.

1.3.9. Marking

Each valve shall be permanently marked with a plate securely fixed to the body with the information as specified under clause 15.1 of IS 14845.

The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.3.10. Acceptable makes for the valves

Acceptable makes for the kinetic double orifice air valves shall be approved by the chief engineer.

1.3.11. Installation

The installation of the air valves shall be done with isolating sluice valve. The job covers supply of the valves at the work site including all taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section

1.4 NON RETURN VALVES

1.4.1 General

Non-return valves generally conforming to IS 5312 Part I & II (Single or Multi Door Type) shall be provided. The valves shall be suitable for continuous use at their pressure rating within the temperature up to 60^0C and shall be conforming to following specifications and requirements.

1.4.2 Design

- The non-return valve shall be swing check reflux valve type with Single or multiple doors.
- The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.
- Valves shall possess inbuilt high speed closing and non-slam characteristics achieved by suitable disposition of weight on door and the hydraulic passage.
- Valves of multi-door type shall be additionally provided with a supporting foot.
- All faces and seat rings shall be riveted to the machined surface in the Casting. The door shall be integral with the hinge and shall have a flat seating face. Minimum two (2) nos. suspension lugs shall be cast integrally on the diaphragm plate and shall be of adequate strength.
- No spring loaded/ spring return action or external dampening arrangement will be acceptable. All the Non-return valves shall be from the same manufacturer.

1.4.3Material

The material for different component parts of Multi-door Non return valves shall conform to the requirements given below:

Component	Material of construction
Body / Door (& Diaphragm)	Ductile Iron GGG 40 / IS 1865 Gr. 500/7 to IS 1865 OR Cast steel grade B conforming to IS 1030
Stub pin	SS AISI 410
Seat & Face rings	Soft seated up to 300 mm. 350 mm and above: Gun metal : IS 318 Gr. LTB 2
Rivets	Soft annealed brass
Fasteners	Carbon steel
Painting	Liquid epoxy coating of DFT 300 microns with proper Blast cleaning to near white - SA 2 ½ Grade and 2 coats of epoxy based primer coating, prior to final coating.
Flange Drilling	IS 1538 Table 4 & 6/ BS En 1092 – 2

1.4.4 Nominal pressure

The working pressure on the valves shall be appropriate to the working conditions and approved by the Employer.

1.4.5 Marking

All valves shall be marked to show the following information permanently.

- Manufacturer's name or trade mark.
- PN rating
- Valve size
- Direction of flow

1.4.6 Factory Tests

The following tests shall be conducted on the valves at manufacture's works before painting. The tests shall be generally as per IS 5312 Part 2.

- **Body Test**

  Body of each valve shall be hydrostatically pressure tested at 1.5 times its rated working pressure. The test fluid shall be water. Duration of test shall be 2 minutes. There shall be no leakage or permanent distortion of any component under the test.

- **Seat Test**

  Each valve shall be tested for seat test by applying hydrostatic test pressure equal to its rated working pressure, on outlet side. Duration of test shall be 2 minutes. During the test, there shall be no leakage of water through the seats.

1.4.7 Manufacturer's certificate

The manufacture shall provide a test certificate confirming that all the valves have been tested in accordance with above specifications and relevant IS 5312 Part II.

1.4.8 Acceptable makes for the valves

Acceptable makes for the double flanged butterfly valves shall be as approved by the chief engineer.

1.4.9 Installation

The job covers supply of the Non-return valves at the work site including all taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section.

1.5 Anti Vacuum Valve:

1.5.1 Scope:

The Anti vacuum valve will be installed to prevent the formation of vacuum in large diameter (having Ø of 1000 mm. and above) water mains to prevent line collapse under such conditions of flow as may result, for example, from too rapid a closure of an upstream head gate or shut down valve, a down stream burst or ordinary emptying or recharging of a pipeline.

1.5.2 Design features:

Design of the anti – vacuum valve shall automatically allow induction of large volumes of air to prevent vacuum formation; and also provide an automatic means of ventilating a line when it is being emptied of water, and of exhausting air when it is being recharged.

It should be suitable to react automatically, sensitively, and positively even after long periods of inactivity, to changes of pressure within a pipe, and whenever necessary, permit air to flow in at a sufficiently high velocity, and at low enough induction pressure, to safeguard the line against collapse.

Cowled Inlet Type of the anti - vacuum valve should have an annular cowl shrouding the orifice, providing protection to the orifice and the seating. It should be suitable for air to flow through the ports provided around the periphery of the body assembly. Such application is confined to situations where no damage is likely to occur surrounding structures from sudden intakes of air.

1.5.3 Operation :

About Operation, the valve element should be in the form of the disk which is sensitively balanced by a counterpoising mechanism. The disk guide pin should be attached to a crosshead, to which is fitted at either end a cranked lever that should

rock about an intermediate pivot pin and should be applicable to carry an adjustable counterweight on its outer arm. The parts should so arranged that by adjusting the position of the counterweights, the valve must be balanced at any desired points on its working travel.

Thus, when swinging freely the valve may be balanced at a partially opened position in which case, if it is closed by hand, it self-opens to the pre determined point of equilibrium, and vice- versa. Also attached to the crosshead should be an oil dashpot which should give free opening, in a downward direction, but offer resistance to closing, in an upward direction, and avoid all possibility of oscillation of the suspended.

In action, therefore, the valve should not remain at either extremity of its travel unless it is acted upon by some external force. During normal operation, the disk should be held shut by the water pressure in the pipe. If the pressure on the underside of the disk falls below that of the atmosphere, the valve should immediately open to admit air and break vacuum. With very small vacuum, say 1 inch of mercury or about ½ psi below atmosphere, should open fully and offer a wide passage for free flow of air. On the cessation of air inflow, the valve must return to a position of slightly open, which is sufficient for the escape of air during refilling of the line. When the rising water makes contact with the underside of the disk, closure is completed: only a very small water pressure should be required to close the valve, consequently, the quantity of water over- flowing through the orifice during final closure will be negligible.

1.5.4 Manufacturer's Test certificate

The manufacturer shall provide a test certificate confirming that all the Anti vacuum valves have been tested in accordance with the relevant standards and performance of the test results observed.

1.5.5 Inspection

The inspection and testing of the sample Anti vacuum valves shall be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop before application of any paint. The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be paid by the contractor to the inspecting agency.

1.5.6 Marking

Each valve shall be permanently marked with a plate securely fixed to the body with the information as specified under relevant standards.

The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.5.7 Acceptable makes for the valves

Acceptable makes for the Anti vacuum valves shall be as approved by the chief engineer.

1.5.8 Installation

The job covers supply of the Anti vacuum valves at the work site including all taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section.

1.6 PAINTING SPECIFICATION FOR VALVES :

Final coating on internal and external surface of the Valve shall be carried out after satisfactory testing, prior to dispatch.

Before inspection : Each valve shall be cleaned and surface shall be prepared by Sand blasting to SA 2½ Grade – Near white blast cleaning, and suitably protected by applying one coat of two component high build polyamide cured re-coatable zinc phosphate epoxy primer.

After inspection : One coat of two component high build polyamide crude re-coatable epoxy coating shall be applied to achieve DFT 150 micron, followed by one coat of two component aliphatic polyurethane finish to achieve DFT 80 micron.

2Surge Control System For Pumping Main shall be as approved after surge analysis.

2.1Accepted Control System

2.1.1 Following types of control systems are acceptable for control of water hammer pressures in the pumping mains.

a) Zero Velocity Valves

b)Air Cushion Valves.

c) Surge anticipating valves

d) As may recommended by the surge analysis report

2.2Surge Control System – Requirements

2.2.1. The requirements given are tentative. The contractor, after award of contract, must carry out the surge analysis based on the Longitudinal section, Pump and Motor characteristics of the selected pumps by the contractor. Surge analysis along with the selected system.

2.2.2. During detailed engineering following information must be submitted based on the Surge Control System' selected by the contractor. For design of surge control system limits will be adhered to (The surge pressures will be estimated after all working pumps at designed discharge, trip simultaneously) as may be approved after the surge analysis report from the expert.

2.3 Scour Valve /Silt Ejector

These valves are to be provided at regular interval at suitable location nearby local / natural drainage in the rising main / distribution network

5.4Pressure sustaining valves / regulating valves.

Suitable size of pressure regulating or sustaining valves to be provided at pump house. These valves shall be suitable to relief the excess pressure built in the pipe line in the event of some outlet chaks are closed and while pumps are in operation. Or these valves shall safeguard the pipe line by maintaining the defined operating pressure range.

These valves shall be auto regulated type by the pipe line pressures and shall be hydraulically operated by the flowing media, and the bleed of water shall be routed back to the sump / forebay.

PART - C

HYDRO – MECHANICAL WORKS

HYDRO – MECHANICAL WORKS

1.1Scope of Work

The scope of work includes, but not limited to the following:

1. Designing, supply and manufacture, inspection, shop assembly, testing, painting, transportation etc.

2. Site storage, including insurance transportation and handling, site erection, painting, testing and commissioning including provision of labour, plant material etc. for the above.

3. Handing over to employer/supply of necessary spares of 2 years trouble free operation/ supply of installation of all incidentals not specified but is necessary for proper completion and satisfactory functioning of the system.

It is not the intention of these specifications to specify complete details of equipment. However, the Contractor shall supply the equipment which will meet in all respects, the requirements of employer in regard to performance durability and satisfactory operation. All the equipment supplied shall conform to the relevant Indian Standards. Wherever, Indian Standards are non-existent or silent, relevant International Standards (as agreed between the Employer and the Contractor) shall be followed. The sizes and numbers of units in each case are based upon employer's preliminary design and may vary to suit modified site conditions and design requirements.

1.1.1 Gates :

Suitable number of gates will be provided at the entrance of drain/ canal.

1.1.2 Gates at Draft Tube Tunnels

(a)Gates.
(b)Embedded parts (Primary and Secondary).
(c)Portal frame gantry crane of adequate capacity

1.2 Trash rack Frame

1.2.0 General Description of Equipment

1.2.1 Gate

Gate shall be designed with welded steel fabrication of skin plate supported by stiffener, main girder, vertical stiffener, side track, seals and guide etc. The gate shall be designed to withstand the head corresponding to minimum water level and it shall be suitable to lower under flowing condition and raising under unbalanced condition.

Each unit shall be fitted with bottom seal, side seal, track and guide roller assembly. The Stoplog gate shall be designed as per IS: 5620.

1.2.2 Embedded Parts

Embedded parts shall be provided. Guides shall be provided up to the suitable height.

1.2.3 Hoisting Equipment

Hoist for Gates – The gates shall be operated by means of dedicated Electrical Operated hoists. The operating equipment shall consist of fixed rope drum type hoist provided on gantry. It shall have all breaking and control arrangement and overload protection devices. Hoist shall also have manual operation facility in case of power failure. Length of drum shall be such that not more than two layer of rope are winded on the drum.

1.2.4 Spare Parts

The mandatory spare for various gate hoist, and cranes shall include one set of rubber seal for all gates, one set of wheel assembly for fixed wheel gate, one set of Brake shoes for rope drum hoist etc. In addition to above mentioned spare if the bidder feel necessary additional spares may also be suggested.

1.2.5 Material

All material incorporated in the equipment shall be new, unused and of first commercial quality, free from defects and as per relevant India standard. Materials for various components of Hydro-mechanical equipment shall conform to the requirements given in Annexure.

1.2.6 Design

All gates shall be designed in accordance with the requirement of relevant India standard. For extra condition of loading such as earthquake condition, storm condition, Brake down torque condition etc. permissible design stress shall be increased by $33^{1/3}$% over the normal storm but limited to 80% of yield point. In case of fastener the increase in the storms for worst loading case shall be limited to 25% only.

The embedded parts of gate shall be designed to limit the bearing pressure on 2^{nd} stage to 25% of compressive strength of concrete.

1.2.7 Embedded Parts

All the sealing faces in the embedded form shall be of stainless steel. The wheel track and sliding track shall be of non-corrosive steel. The BHN of wheel track shall be 50 points higher than wheel rim. The entire track shall be machined after welding. Roller path, seal parts and guide track shall be provided up to height indicated below.

Guide track-Full travel of gate.
Track-Unbalanced operation – twice the gate height + 1 m
Track -Balance operation – gate height + 1 m

1.3Gate Seals

All gate units, zero shaft gate, draft tube gate shall be provided with natural rubber / Neoprene sealing elements in a sections appropriate to the functional requirements and gate type. In cases where low frictional resistance is necessary, the seals will be provided with a PTFE insert bonded during the moulding process. Thickness of bottom seal shall not be less than 20mm and this shall be of wedge type. All corner seals between lintel seals and side seals shall be of continuous moulded piece. All seals will be clamped to gate units by stainless steel fasteners. Suitable chamfer shall be provided in the base plate and clamps of seal assembly. The properties of natural rubber / Neoprene seals shall be as under:

a)Shore Adurometer hardness 65+5

b)Minimum elongation 450%

c) Ultimate tensile Strength (Minimum) 14.5 N/mm^2

d) The rubber compound shall not absorb more than 10% by weight, of water in 7 day test

e) The tensile strength of the test specimen, after being subjected to an accelerated ageing test of 48 hours in oxygen at 70^o C and 2.1 N / mm^2 pressure, shall be not less than 80% of the strength of the test specimen before ageing.

1.4Frictional Resistance

The following frictional resistance co-efficient shall be adopted in the Design of gates and associated equipment.

Sl. No.	**Item**	Static	Dynamic
1.	Rubber seal on Stainless steel	1.5	1.2
2.	Seals with PTFE inserts	0.2	0.15
3.	Roller bearing Factor	0.015	0.01
4.	Self –lubricating bearing	0.2	0.15
5.	Plain bearings	0.4	0.3
6.	Steel on steel	0.6	0.4
7.	Brass or bronze on steel	0.5	0.3

1.5Operating Equipment

The capacity of the hoist and crane for various gates and stoplog units be calculated on the basis of self weight of the gate, weight of lifting beam (where applicable) frictional forces (including static seal friction, wheel / trunnion friction, hoist friction, silt load etc.) and down pull forces. The hoist capacity thus arrived shall be increased by 20 percent to cater for reserve hoist capacity.

Similarly in the case of gates designed for closing under self weight, the downward forces closing the gate while lowering shall be at least 20% higher than the forces opposing down ward motion. However the sealing pressure shall not be less than the values mentioned in the IS code.

1.6 Gate Seal Leakage

The leakage allowance for gate as well as stoplogs and bulkheads shall not exceed the permissible limits.

1.7 Gantry Cranes and Hoists

Mono/double rail cranes and hoists for handling the various stoplogs / gates shall be designed and shall conform to requirements of applicable to Indian codes. Cranes will be classified according to its specific duty, service life and load status gear mechanism. The winding drums shall have single layer of rope, as far as practical.

Mono/double rail cranes shall be supplied complete with rails equipped with necessary anchorage to withstand wind and seismic loads transmitted from the gantry structure. Electro-mechanical hoist shall consist of wire ropes, drums, reduction gear, couplings, brakes, electric motors, limit switches. Both electro-magnetic and thruster brakes shall be provided on hoist drives where LT and CT drives shall be equipped with electro magnetic brakes. Necessary provisions for connections to remote control system shall be provided on local control panels.

1.8Lifting Beams

The lifting beams for handling the stoplog sections will be of the automatic type, being preset to release or engage the hooks prior to lowering. Presetting is by manual positioning of a central counterweight system, and an interlock arrangement prevents premature release of the hooks during lowering. A probe rod incorporated in each stoplog unit releases the locking arrangement when the section is fully lowered, enabling the hooks to disengage.

1.9 Rope Drums and Wire Ropes

The rope drums and wire ropes shall conform to the Indian Standards in general. The ropes shall conform to IS 2266 improved plow steel and fiber core extra flexible high grade improved wire rope. The ropes shall have a factor of safety of six (6).

The drums shall be made of cost steel of fabricated from steel plates and shall be reinforced to sustain concentrated loads due to rope tensions. The drums shall have a diameter not less than 20 times the rope diameter and shall have sufficient length to adopt full length of rope of specified lift and number of falls, in one layer plus two idle turns at each fastening end and minimum one extra groove. The drums shall be checked for crushing and combined stress as per IS – 6938.

1.10 Electrical Equipment

All electrical equipment, including motors, starters, control panels, Solenoids and associated instrumentation shall be of international standard and shall be suitable for the climatic conditions prevailing at the project site and shall be provided with all necessary anti-condensation heaters and other protection against the ingress of dirt and insects.
All motors shall be induction type with water tight terminals, anti-friction bearings and built in totally enclosed fan ventilated enclosures. All motors have speed not exceeding 1500 rpm. Creep speed motors shall also be continuously rated. All hoists including crane hoists shall be provided with at least two sets brakes working on different principles viz. Electromagnetic, thruster, eddy current braking system etc.

All motions shall be provided with limit switches at both extreme ends of travel. For hoist motion the system shall be provided with overload limit switches and slack rope limit switches. Indications and protections shall be provided on the control panel.

1.11 Inspection & Tests

All materials shall be of tested quality and all work performed shall be subject to rigid inspection and no articles or materials shall be dispatched until all tests, analysis and shop inspection have been completed or certifiedcopies of reports or results of tests and analysis have been accepted. Duplicate copies of manufacturer's test certificates including chemicals analysis and mechanical properties shall be made available for all materials. In case test certificates are not available for any of the material the same shall be got tested and only these materials which fulfill the requirements of these specifications shall be used. From any part / item, it should be possible to locate its manufacturer's batch / lot mark, which shall be achieved by transferring the batch marks before parting the materials.

All castings shall be annealed and forging shall be normalized.

1.12 Shop Assembly and Testing

During the course of manufacture, the equipment included in the scope of supply shall be subject to rigorous inspection and testing.

All components, sub-assemblies and assemblies will be dimensionally and functionally checked against the relevant drawing.

All gate units shall also be fully shop assembled (with temporary bolting where necessary), and checked for dimensional and flatness checks with all fitments such as wheels, guides, seals, bypass valves etc., attached. The correct Center of Gravity shall be established during shop assembly before final welding of lifting lugs.

Reception frames and guides shall be assembled on the shop floor for dimensional and straightness checks, also alignment of connecting members with the required tolerances.

In all cases the various connecting parts shall be match marked to facilitate site erection.

Hoisting units shall be fully assembled on the hoist platform and test run to at least 20 minutes and load tested to 1.25 times the rated capacity. All lifting beam shall be shop assembled and hooks will be similarly load tested. Automatic engaging and dis-engaging of lifting beam hooks shall also be tested in the shop. During test run all the components of the hoist shall be tested for their performance.

The gantry crane / monorail crane and hoist shall be fully shop assembled and tested to 1.25 times the rated capacity. The hoist shall be operated for 15 to 30 minutes in slowest speed to demonstrate that equipment has been designed for continuous duty. The gantry crane shall be made to travel for a distance of 30 m if so permitted or otherwise the driving wheels shall be rotated under power, by jacking of wheel carriage / crane.

Trashrack cleaning machine, shall be completely assembled and shall be tested for operation with load. The hydraulic thruster winches are to be tested for proper operation with load. Simulation load test at 125% on hoists and gear drive shall be carried out. Raking operation shall be performed above the deck level.

1.13 Site Testing and Commissioning

All embedded reception frames and support frames etc., shall be erected and checked for dimensional accuracy and alignment in accordance with the assembly drawing with the required tolerances and level limits before and after concreting

After site assembly of the gate units within their respective reception frames, all gates will be checked for roller alignment, seal compression and guide clearances.

The operating equipment will be checked for correct positioning and alignment, and undergo full functional tests over the operation range of the particular gate, checking operating speeds and performance of the hydraulic and electrical control systems.

Hydraulic systems will be pressure tested to 1.5 times the maximum rate operating pressure.

Gantry cranes and hoisting winches shall be load tested, all in accordance with standard.

1.14 Non Destructive Test

The fabricated gate / stoplog units, embedded parts, penstocks, hoist components and other load carrying members, shall be subjected to the following Non destructive tests.

1.15 Steel

i)	Butt welds	Rediography	100%
ii)	All fillet welds in the gate beam, end plate and lifting point	Magnetic particle	100%
iii)	Other fillet welds	Magnetic particle	10%
iv)	Root runs of important load bearing joints	Dye-penetrant	100%

1.16 Casting and Forging

Castings Ultrasonic Level I SA 603 ASME Sec. V Forgings Ultrasonic SA388 ASME Sec. V 2.3.20

1.17 Stress Relieving

Trunnion bearing hub casting prior to machining shall be stress relieved, if welded. Yoke girder and the anchor girders shall also be stress relieved. Elsewhere welded plates thicker than 28 mm will also be stress relieved. The procedure for stress relieving shall be per ASME section VIII Division –1.

1.18 Surface Preparation and Painting

All exposed and under water steel works shall be sand blasted to at least Sa 2 ½ quality of Swedish Standards. SIS 055900. The bidder shall clearly indicate the

painting system proposed by them for under water as well as exposed surfaces of steel works including liners indicating the type of primers, protective coatings, No. of coats proposed and their dry film thickness. However, the dry film thickness should be around 70-80 microns for primer protections and 400 microns (in two coats) for final paintings.

1.19 General

The bidder shall include necessary ladders, platforms, handrails in and around gate installations in order to provide approach for inspection and maintenance. Removable steel covers shall also be provided on gate openings at deck level wherever required.

Necessary cabling (within this scope of work) for various hoist installations including remote control system shall be provided by the bidder without additional cost to the Employer.

The bidder shall prepare detailed technical specifications, design calculations, general arrangement, assembly, subassembly and detailed fabrication drawings and inspection drawings for various components of works and submit the same for the approval of the employer. Fabrication shall be taken up only after approval of the above by the employer. All schematic wiring diagrams, control circuit, drawings, hydraulic piping and installation drawings and hydraulic circuit diagrams along with detailed write up shall also be submitted for approval.

The meter, kilogram, second (MKS) System shall be used for this contract where manufacturer's products are produced in imperial sizes, substitutions shall be made to nearest metric size. All drawings, calculations, design data and instructions manuals shall be in MKS units. For manufacturer's convenience imperial measurements may be placed in brackets after the MKS units.

Bidder shall indicate the approximate weight of the various components of each gates and its hoists.

a. Weight of gates / stoplogs / bulkhead
b. Weight of embedded parts
c. Weight of hoists / cranes and its capacity
d. Weight of hoist supporting structure
e. Weight of lifting beams

1.20 LIST OF I.S. CODES REQUIRED IN GENERAL

Sl. No.	Description	IS Number
1	Recommendation of structural design of fixed wheel gates	IS 4622
2	Recommendations for structural design criteria for low head slide gates	IS 5620
3	Recommendations for structural design of medium & high head slide gates	IS 9349
4	Code of practice for design of rope drum and chain hoists for hydraulic gates	IS 6938
5	Code of practice for electric overhead Traveling cranes other than steel works cranes	IS 3177
6	Code of practice for design manufacture erection & testing of cranes & hoists.	IS 807
7	Code of practice for use of structural steel in general building construction	IS 800
8	Design criteria for hydraulic hoists for gates	IS 10210
9	Recommendation for inspection testing & maintenance of fixed wheel & slide gates	IS 7718 (Part – I)
10	Recommendation for inspection testing & maintenance of fixed wheel & slide gates	(Part – II)
11	Recommendation for inspection testing & maintenance of fixed wheel & slide gates	(Part – III)
12	Recommendation for Inspection, testing & maintenance of Radial gates & their hoists	IS 10096 (Part – I)
13	Recommendation for Inspection, testing & maintenance of Radial gates & their hoists	(Part – II)
14	Recommendation for Inspection, testing & maintenance of Radial gates & their hoists	(Part – III)
15	Approval test for welding procedures (Part – I)	IS 7307 (Part – I)
16	Approval testing of welders working to welding procedures	IS 7310 (Part – I)
17	Approval tests for welders when welding procedures approval is Not required	IS 7318
18	Code of practice for liquid penetrant flow detector	IS 3658
19	Code of practice for Ultrasonic tube echo testing by contact and immersion methods	IS 3664
20	Code of practice for magnetic flow detector	IS 3703
21	Code for unfired pressure vessels	IS 2825
22	Code of practice for radiographic testing	IS 2595
23	Code of practice for structural safety of buildings : Loading Std.	IS 875
24	Code of practice for plain & reinforced concrete	IS 456
25	Criteria for Earthquake resistant design of structures	IS 1893
26	Steel wire ropes for General Engg. Purposes	IS 2266

1.21 TRASHRACKS

The structural steel for trashrack bearing plates including anchor plates and bolts shall be assembled as shown in the approved drawings. All structural steel for trashrack will be shop fabricated in convenient sizes for transport, accurate positioning and alignment of the bearing, guides will be required to ensure that the rack sections will properly site / slide. The trashrack section will be furnished completely fabricated and will require only setting in position as directed or shown in the drawings. Rack shall be cleaned, painted and installed as shown in the drawing or as directed.

Each trashrack panel shall be so nearly rectangular that the diagonal dimensions will not vary more than 12 mm. Each trashrack shall be properly supported on the supported structures consisting of R.S.J's, channel, angle as specified in the approved drawings. Line level and centers of the supported structure shall be properly checked before final placement of trashrack.

1.22 Measurements for hydro-mechanical works will be made for making the progressive payments against the total contract price for the work.

ANNEXURE A

SPECIFICATION OF MATERIAL

Materials for various components of Hydro-mechanical equipment shall conform to the requirements given below. The successful bidder should submit the exact specification of material proposed by them in this Annexure before execution of work

Sl. No.	Component	Material Conform to
1	Gate, Embedded parts, groove-liner, bonnets etc.	
	a) Steel Plate	Mild steel weldable quality
	b) Rolled section	Mild Steel Weldable quality
2	Main rollers, Guide roller,	
		Cast steel
		Forged Steel
3	Self-lubricating bearings and washers	"Lubrite" or approved equal
4	Main and guide roller axles	Corrosion-resistant Steel
5	Side Guides	
	a) Steel plate	Mild steel weldable quality
	b) Rolled Sections	Mild steel-weldable quality
6	Main Roller track	Corrosion – resistant steel
7	Side and back roller track	Carbon steel
8	Sealing surfaces	Corrosion-resistant steel
9	Seal fasteners	Corrosion-resistant steel
10	Structural members of hoist platforms, columns etc.	
	a) Steel plate	Mild steel- weldable quality
	b) Rolled sections	Mild steel- weldable quality
11	Hoist drums and achieve	Steel platge - weldable quality, cast steel
12	Gears	Cast steel
13	Pinions	Forged steel
14	Pins, shafts, sheave, axles, less than 75 mm dia above 75 mm dia	Cold rolled steel corrosion resistant steel, carbon steel, Forged steel, Corrosion resistant steel
15	Wire rope	6 x 37 construction
16	Bearing Pedestal	Cast steel
17	Bronze bush other than specified above	Plain bronze
18	Lifting pins	Carbon steel Corrosion resistant steel
19	Bolts for connecting flange plates of Hydraulic Hoist	Corrosion – resistant Steel
20	Spherical / roller bearings	SKF, FAG or approved equal
21	Machine bolts and nuts	Carbon steel
22	Steel plate for penstocks	Pressure vessel quality plate

PART D
ELECRTO MECHANICAL WORKS

PUMPS

2.1.1. SCOPE:

I. The scope of this section covers design, manufacture, testing at manufacturer's works before dispatch, supply, delivery at site, erection, testing and commissioning of VT pumps each along with valves (H.O.P.D and E.O.P.D) in delivery line and with all associated auxiliary and ancillary equipment including OPU system for MDV and all other auxiliary equipment like compressed air, electrically operated valve with all associated equipment, dewatering and drainage, lubrication systems, water and air piping with necessary instrumentation, control and safety devices etc. complete with all accessories, mandatory spares, special tools and plant as detailed in the specification The scope of supply shall also include all parts, accessories, and spaares etc., which are required for construction, operation and maintenance of Pump – Motors, even though these are not specifically stated or enumerated. The corresponding parts of all the Pump -Motors, associated equipment and spares shall be of same material dimensions, workmanship and finish and shall be interchangeable.

II. The scope of supply shall also include all parts, accessories, and spares etc., which are required for construction, operation and maintenance of Pump –Motors, even though these are not specifically stated or enumerated. The corresponding parts of all the Pump -Motors, associated equipment and spares shall be of same material dimensions, workmanship and finish and shall be interchangeable

1.2Tentative Parameters of DPSs:

S. No.	DPS Name	Discharge	Working Pumps	Stand by Pumps (50% Standby)	Future Pump bays	Discharge of each Pump	Head	Required Capacity of each pump	
							Total		
		Cumecs	No's	No's	No's	Cumecs	m	HP	KW
1	Big Hospital	1.810	2.0	1.0	1.0	0.905	10.500	175.0	135.0
2	Khagul - Danapur Near Hitech Hospital	2.380	2.0	1.0	1.0	1.190	11.500	250.0	190.0
3	Bakri Bazar	2.710	2.0	1.0	1.0	1.355	12.000	295.0	220.0
4	Karori chak	2.760	2.0	1.0	1.0	1.380	15.000	375.0	280.0
5	Dasaradha	3.190	2.0	1.0	1.0	1.595	12.000	350.0	265.0
6	Digha (Near Old Thana)	3.450	2.0	1.0	1.0	1.725	13.000	405.0	305.0

S. No.	DPS Name	Discharge	Working Pumps	Stand by Pumps (50% Standby)	Future Pump bays	Discharge of each Pump	Head	Required Capacity of each pump	
							Total		
		Cumecs	No's	No's	No's	Cumecs	m	HP	KW
7	Nandal Chapra	3.870	2.0	1.0	1.0	1.935	12.500	440.0	330.0
8	Premkunj (Kamali Chowk)	4.110	2.0	1.0	1.0	2.055	12.000	445.0	335.0
9	Rajiv Nagar	4.240	2.0	1.0	1.0	2.120	11.500	440.0	330.0
10	Buer Bethode Pul	4.700	2.0	1.0	1.0	2.350	12.500	530.0	400.0
11	Isopur Brama Ashta	4.760	2.0	1.0	1.0	2.380	12.500	540.0	405.0
12	Gurudaur Nehru Path	6.700	4.0	2.0	1.0	1.675	13.500	410.0	310.0
13	Kanpur	18.770	6.0	3.0	1.0	3.128	11.500	650.0	485.0
14	Bermutta	18.870	6.0	3.0	1.0	3.145	11.500	655.0	490.0

PUMP -MOTOR:

Type and rating.

I. The pump shall be of vertical shaft, single stage **suitable for direct** coupling to motor of **suitable** capacity with 10% over load rating. The direction of rotation shall be anti-clockwise when viewed from top. Each pump shall be so designed and constructed that all removable parts including runner, shaft, guide bearing, shaft seal, guide apparatus etc., can be easily removed. It shall be possible to repair/replace pump shaft seal without de-watering the Draft tube, for which purpose additional repair seal shall be provided. .

II. The pump shall be capable of giving rated discharge **(approximate)** with maximum of **rated suitable power input** to the motor, at rated voltage and frequency. The bidder shall evaluate the losses in the water conductor system to arrive the dynamic head and shall design pump-motors accordingly. The net head and Gate opening at which the machine gives the best efficiency shall be indicated, while delivering the rated discharge. The pump shall be designed and constructed to operate satisfactorily with complete safety and without objectionable vibrations, noise and cavitation at all heads within the range of head variation indicated above.

(y)

III. The maximum discharge and the corresponding gate opening at minimum and maximum net head, best efficiency head shall be stated in the offer. Capability of pump for giving higher output shall also be stated in the offer. Graphical data regarding the gate opening, discharge, efficiency, shall be furnished along with the bid. The pump shall operate satisfactorily for a variation in capacity up to 125% of the rated capacity at a head of indicated above at higher frequencies (

50.5 Hz). The bidder shall indicate clearly the suitability of the pump for operation at heads higher than the designed net head

(z)

CHECKING GUARANTEES FROM MODEL TEST RESULTS:

Field test as per IEC form the final basis to establish the fulfillment of guarantees. The purchaser shall have option of carrying out the field test by the manufacturer. Such tests shall be to the bidders account

Penalty on account of fall in weighted Average Efficiency and output:

For any shortfall in the tested values of rated output and weighted Average Efficiencies (as determined by the following basis) from the guaranteed values, a penalty shall be applicable at the rate of Rs.2,50,000(Rupees two lakhs fifty thousand only) per pump for each 0.01**% (one hundredth percent)** by which the test figure is less than the corresponding guaranteed figures. The penalties on account of the output and efficiencies shall be computed separately and the total amount of penalty shall be the sum of these two. No tolerance limit shall be permissible over the test figures of rated output. Tolerance on measurement of efficiencies shall be allowed in accordance with the IEC test code or any other equivalent standard for Field tests of pumps

Rejection Limit:

The purchaser has right to reject the equipment if the test values of either weighted average efficiency (as determined on following basis) or the rated output falls below 3 % of the corresponding guaranteed figures as per IEC standards.

Computation Of Weighted Average Efficiency:

The weighted average efficiency of the prototype machine shall be determined from the guaranteed and field test values of the efficiencies at the rated Static head in accordance with, for the purpose of penalty and rejection limits of efficiencies guaranteed.

RECTIFICATION TO MEET GUARANTEES:

The bidder shall make good and meet the guarantees again within a period of 4 (Four) months from the date of witnessing the original tests, should the original test be unsuccessful in meeting the guarantees. However, no delay in the original delivery schedule shall be allowed due to this reason

The penalty or rejection shall be applied if the second attempt is also unsuccessful in meeting the guarantees.

CAVITATION GUARANTEE:

I. The Bidder shall guarantee the runner, discharge ring and other hydraulic passage against excessive pitting caused by cavitation for 60 months from date of commissioning or 12,000 hrs. of actual operation, whichever is earlier.

II. Excessive pitting shall be defined as the removal of metal from runner and other passages exceeding a weight of $W = 0.1D^2$ per 1,000 hrs of operation during the guarantee periods defined above, where W is weight in kg. and D is the throat diameter of runner in meters. The bidder shall indicate the method which he proposes to use for measuring the amount if the metal removed on account of cavitations, which shall be subject to the approval of purchaser.

III. If the 60 months guarantee period expires prior to the completion of 12000 hrs. of actual operation, the bidder shall guarantee, that the weighted loss shall not exceed the value proportional to the number of hours actually operated.

IV. In case of excessive cavitations being present, the Bidder at his cost shall correct the condition and rectify and/or replace the part thus affected. The pump after such modifications and repairs and/or replacements of part or parts shall be subject to the same cavitations guarantee as for the original equipment.

V. In determining whether or not excessive pitting has occurred, metal removed by erosion, corrosion by the presence of injurious foreign element in water or by chipping and grinding preparatory to repairing the pitted area, shall be excluded. The manufacturer shall adopt necessary improvements modifications in the designs, manufacturing to minimize the cavitations pitting within the permissible limit.

CRITICAL SIGMA:

Values of critical sigma as calculated by IEC code or any other equivalent standard on the basis of model test for pump shall be given in the form of curves efficiency versus sigma for different heads of operation. Plant sigma curves shall also be plotted on it to clearly show the safety margin available. Cavitations model tests shall also be given.

SPEED REGULATION:

The limits on speed rise shall not exceed the values given in the schedule of guaranteed technical particulars of this section.

RUNAWAY SPEED AND NOISE GUARANTEES:

The maximum runaway speed of the pump under any combination of cistern water and surge pool water conditions shall be stated. The pump shall be capable of running safely at the maximum runaway speed, without damage to its parts for not less than 15 minutes, on every such occurrence. The duration for which the pump can run at runaway speed safely shall be stated in the offer.

Maximum noise level of operation shall be 120 decibels, and the guaranteed value shall not exceed 120 decibels in the machine hall. The bidder shall supply necessary instruments for recording & analyzing vibration levels & shall include these in the bid.

MODEL TESTS

I. Model test shall be performed by the bidder (before commencement of manufacture of the prototype) in the presence of the Purchaser's representative to demonstrate the efficiency and other guarantees as well as requirement of specification for the performance of pump shall be met. Model tests shall be carried out as per IEC test codes or any other equivalent standards which is more stringent.

II. The hydraulic parts of the model shall be completely homologous with the corresponding parts of the prototype units as per relevant IEC recommendations or any other equivalent standard.

III. Hydraulic performance Tests shall be made to determine machine characteristics. Values of unit torque and unit discharge shall be plotted against unit speed. These tests shall include determinations of capacity, efficiency, cavitations limits, hydraulic thrust, runaway speed etc., and shall be in accordance with relevant IEC or other equivalent test codes.

IV. In deriving prototype step-up efficiencies from model tests data formula given in relevant IEC test or any other equivalent standards shall be used. Similarly, head-discharge relationship shall be stepped up from the model by the affinity law with an additional correction to the discharge as per relevant IEC code or any other equivalent standards recommendations. Cavitations limits of critical sigma shall be determined from the model test.

V. Other model tests as considered desirable to check guarantees or determine operating characteristics under unusual conditions shall be carried out as agreed jointly between the purchaser and the bidder.

VI. Copies of model test reports giving performance of pump operation shall be furnished after completion of model tests to Engineer-in-charge.

VII. The manufacture of prototype pump shall be commenced on approval of model test results by the purchaser.

VIII. Detailed graphs regarding plant sigma and machine sigma shall be finalised at the time of model test.

IX. Photographs and sketches of cavitations phenomena shall be furnished.

(aa)

2.1.2. GENERAL ARRANGEMENT OF PUMP:

The pump shall be so constructed that all removable parts including runner, shaft, guide and thrust bearings and supports, gate-operating mechanism etc., can easily be removed. The design of pump shall permit a vertical movement of the runner shaft by an amount sufficient for adjustment of the thrust bearing and for clearing the joints at the coupling of the pump and motor shaft.

The bearing arrangement of the pump/motor shall be so designed as to ensure trouble free operation of the unit and permit repair/replacement of parts without disturbing the adjacent components.

All equipments shall be readily accessible for operation and maintenance. All necessary walkways ladders, hand rails, chequered plates required for the equipment covered under the specification shall be provided.

Pumps shall be vertical and shaft-driven by vertical-shaft motors. Impellers shall be of the mixed or axial-flow multi-stage type, driven at a maximum speed of 960 rpm unless otherwise specified.

Operation of pumps shall be automatic with working and standby pumps operated in rotation such that no pump shall be operated short duration.

The minimum clearance between adjacent pumps and between pump and wall shall be as per Hydraulic Institute Standards.

For all the pumps the selected model shall be such that the operating point shall lie nearest to best maximum efficiency point but towards the left of the maximum efficiency point.

The impeller diameter selected shall be such that there shall be a minimum of one diameter higher and one diameter lower size impeller is available for all the pumps.

The pump installation shall include SS 316 suction strainer, suction bell mouth, suitable length column pipe, discharge head, motor stool, lower stool, all the accessories, etc. complete.

The total suspension length shall be from suction point at bell mouth up to delivery point at common header as per design. The vertical column shall be suitably supported and anchored to prevent vibrations / movement.

The pumps shall confirm to IS: 1710 and IS: 5120. The pumps shall be capable of handling raw water from a reservoir with expected turbidity up to 1000 PPM.

Vertical-shaft driving motors shall be mounted on the discharge head above the discharge bend. Unless otherwise specified or approved, they shall be of the hollow shaft type, fitted with an axially-adjustable thrust bearing designed to carry the combined weight of pump and motor rotating parts, the drive shaft with couplings, and hydraulic loadings.

Support bearings shall be provided between each impeller stage. The impeller shaft shall be corrosion-resistive low-alloy steel, designed for low stress and long life.

The drive-shaft couplings shall be designed to preserve true shaft alignment in all operating conditions and shall be close to bearings. Coupling design shall provide for accurate assembly and re-assembly within the limits of the permissible end-float of the shaft.

The drive shaft and couplings shall be designed to withstand the maximum accelerating torque of the motor, with a factor of safety of at least two. When required, the Agency shall provide his design calculations to demonstrate that the shaft size chosen meets the requirement for safety factor.

Unless otherwise specified or approved, the drive arrangement shall incorporate an approved ratchet arrangement to ensure that Pump not rotating reverse direction, if the pumps are driven in reverse for any reason, the motor is uncoupled from the pump. Unless otherwise specified, the discharge pipe work shall include an automatic air inlet/release valve, designed to vent the pipe work on pump start and to allow air ingress when the pump stops. The valve shall be sized to ensure that accumulated air shall not be passed to the delivery pipe work on starting. If draining the column pipe on pump stopping could result in reverse rotation of the pump, means shall be incorporated to ensure that the pump cannot be restarted before reverse rotation stops.

2.1.3. CODES AND STANDARDS

The design, manufacture and performance of the pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable Indian or equivalent international standard. Some of the relevant standards are:

IS 1710	:	Vertical Turbine Pump for clear cold fresh water
IS 5120	:	Technical requirement for rotodynamic special purpose pumps

2.1.4. FEATURES OF CONSTRUCTION

The hydraulic design of the pump shall meet the requirements of high efficiency at least 85%, low submergence, high reliability, optimum system design.

The shut off head shall be at least 110% of the total head and maximum of 130 % of total head.

The first critical speed for the pump rotor shall be at least 30% above the operating speed.

Pumps shall run smooth without undue noise and vibrations. The velocity of vibrations and the noise level shall be as per latest IS code. To detect excessive vibrations exceeding design limits as per standards, three axis vibration monitors shall be installed on the motor at top. The motor shall stop automatically when the vibration exceeds the limits.

The power rating of the pump motor shall be higher of the following:
115% of the power input to the pump at duty point at a speed corresponding to given frequency.

Maximum power input while operating single pump corresponding to the speed of 50 Hz.

Pump impeller shall be both statically and dynamically balanced.

The pumps of a particular category shall be identical. Components of identical pumps shall be interchangeable.

Pump shall be provided with non-reversible ratchet to prevent reverse rotation.

All pumps shall be provided with suitable protections including protection against overload, bearing failure, increase in bearing temperature etc.

All accessories required for proper and safe operation shall be furnished with the pumps.

Pump and motor shall be selected for VFD operation in variable frequency.

2.1.5. REVERSE ROTATION

Non-reverse ratchet arrangement shall be provided to prevent reverse rotation. However, the unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to water returning through the pump at times when the power supply

to the motor is interrupted and the valve fails to disallow reverse flow and non-reverse ratchet arrangement fails.

2.1.6. NOISE AND VIBRATION LEVEL

Pumps shall run smooth without undue noise and vibration and noise level shall be limited to

a) Sound: 85db at a distance of 1.5 m.

b) Vibration : 4.5mm/s velocity. (Measured vertical, Horizontal and axial)

2.1.7. COLUMN PIPE

i. Column pipe shall be steel Manufactured from tubes confirming to either IS 1978:1982 or Gr A of IS 2062: 1984 for depths greater than 80m, the column pipe shall be manufactured from tubes confirming to IS 4270:1983.
ii. The Standard lengths of column pipes shall be 1.5, 2.5 or 3m.
iii. The column pipe may be threaded, flanged or provided with other methods of connection.

2.1.8. GASKET, SEAL AND PACKING'S

Gaskets, seals and packings used for clear, cold water pumps shall confirm with those specified in IS: 5120:1977.

2.1.9. IMPELLER:

i. The impeller shall be ASTM A 743 CF8M may be of the enclosed or semi-open type impeller shall be fastened securely to the impeller shaft with keys, taper bushings, lock nuts or split thrust rings.
ii. They shall be adjustable vertically by means of a nut in the driver or an adjustable coupling between the pump and the driver.
iii. Impeller shall be properly balanced dynamic balancing is recommended. Closed impellers may have a renewable sealing/wear ring fitted on to the front shroud or in the bowl or both.

2.1.10. BOWL

i. The Bowl shall be Cast Iron conforming IS 210:1978 and casings of bowl shall be free of blow holes, sand holes and other detrimental defects, the bowls shall be capable of withstanding a hydrostatic pressure equal one and a half times maximum discharge pressure (this included shut off head).
ii. The bowls may be equipped with replaceable seal rings on suction side of enclosed impellers. Water passages shall be smooth and the bowls may contain bushes to serve as bearings for the impeller shaft.

2.1.11. IMPELLER SEAL RING:

The Wearing shall be ASTM A 743 CF8M wearing ring providing seal to enclosed impeller. It may be either on the impeller or in the bowl or on both.

2.1.12. TRANSMISSION BEARING RING:

The Bowl-bearing/top bowl bearing shall be rubber; bronze conforming IS 318:1981 and bearing used for impeller shafts in each bowl.

2.1.13. IMPELLER/LINE/HEAD SHAFT:

Impeller Shaft shall be stainless steel conforming IS 1570 (Part 5):1895 and it holds the rotating impellers and coupled to the line shaft.

2.1.14. MATERIAL OF CONSTRUCTION

The material of construction for various components shall be as under:

Casing & Suction bell: Cast Iron IS: 210, Grade FG 260

Bowl : Cast Iron IS: 210, Grade FG 260

Impeller : ASTM A 743 CF8M

Impeller Shaft : AISI 410

Head Shaft : AISI 410

Line Shaft : AISI 410

Discharge Head : MS IS 2062 Fe 410WA

Column pipe : MS Fabricated

Transmission Bearing : Rubber backed Bronze

Wearing Ring : ASTM A 743 CF8M

Suction strainer : SS 316

All fasteners including anchors bolts, foundation bolts, washers, nuts etc. in both in wet and dry areas Stainless Steel SS 316

2.1.15. DISCHARGE HEAD AND MOUNTING PLATE

The discharge head shall be a composite fabrication or casting. The supporting-plate assembly shall consist of a steel base plate, strong enough to carry the weight of the complete pumping unit without significant deflection. The assembly shall provide the motor mounting arrangement and support the pump. If required, the supporting plate shall be supplied with a flanged sleeve to facilitate mounting, with a puddle flange for building in.

The following shall be included:

- supporting plate with holding down bolts or studs;
- Bedplate ring with leveling screws and plates;
- Lifting lugs
- Fixings for motor and coupling;
- Provision for insertion of cables and level-recording equipment if required;
- Provision for access to service the shaft seal.

The discharge-head shaft seal shall be selected for long life with minimum maintenance and may be of the mechanical. The pressure limit of mechanical seals shall be at least 50% greater than the pump closed-valve delivery pressure. Provision shall be made to return to the pump well any water leaking past the head seal.

2.1.16. WATER-LUBRICATED LINE-SHAFT BEARINGS

Bearings shall be spaced at the intervals needed to ensure vibration less running at all possible pump operating speeds, with a maximum distance of 2.5 m apart. Guide bearings shall be of resilient synthetic rubber, mounted in spider bearing-retaining assemblies.

The arrangements for supplying filtered water shall ensure:

a) That filters used are duplex type so that one filter can be cleaned while the second remains in service;

b) That if required by the bearing design, a filtered water supply is provided to each bearing before the shaft begins to rotate.

c) That if the installed arrangement makes any reverse rotation possible on pump stopping, if required by the bearing design a filtered water supply is provided to each bearing until reverse rotation stops.

2.1.17. REJECTION

If the shop testing at factory premises, the guaranteed efficiency considering the zero percent negative tolerance, is not met, the pump shall stand rejected.

2.1.18. TECHNICAL DATA SHEET

The bidder shall submit detailed technical data sheet pump with their technical proposal during bidding covering all the details of pumps.

2.1.19. NAME PLATE

All Pumps shall have a stainless-steel nameplate on the body. Project name shall be printed by original manufacture.

EOPD & HOPD VALVE

2.1.20. EOPD VALVES:

Butterfly valves shall be of flanged construction and shall be complete with actuating mechanism, matching counter flanging, bolts, nuts, gaskets, lifting lugs, sole plate for supporting feet in the valve body etc.

2.1.21. DESIGN / CONSTRUCTION / MATERIALS PARTICULARS

The valves shall be designed for the design pressure / temperature as specified and in accordance with IS13095/BS5155.

i. The vales shall be suitable for installation in any position (horizontal / vertical etc.).
ii. All valve components and accessories of the same type shall be perfectly identical in size and material so as to guarantee interchangeability of the parts.
iii. This specification is valid also for the spare parts.
iv. The actuator-operated valves shall be designed on the basis of the following prescriptions.

- The internal parts shall be suitable to support the stresses due to the actuator, the valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.
- All flanged ends shall comply with the standard specified.
- The valve flanges shall be flat faced.
- The Contractor shall furnish the coefficient of capacity of each valve (CV in metric units) and the characteristic curves.
- Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft.
- The operating mechanism shall be mounted directly on or supported from the valve body.
- The Sealing ring on the disk shall be continuous type and easily replaceable.
- Rubber seal shall be fitted on the periphery of the disc by clamping between the disc and clamping ring. The seal design shall be T type and shall be held in machined grooves on the disc and clamping ring. Seal design with clamping bolts passing through seal shall not be acceptable.
- The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body.

The material of bearing shall be self-lubricated type with low coefficient of friction that does not have any harmful effect on water and on valve components. Bearing shall be provided beyond the shaft seal. The housing for this bearing shall be rigidly attached to the valve body.

The minimum length of the disk hubs shall be at least 1.5 the diameter of the shaft or of the stems.
The shaft shall be connected to the disk through keys or taper pins or screws of stainless steel. The connections shall be designed so as to avoid looseness during the operation; moreover, they shall be provided with suitable disassembling systems. The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin or other) for transmitting the torque between shaft and disk shall be capable of with standing the maximum torque required to operate the vale.

The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

All butterfly valves shall have permanent arrow inscription on the valve body indicating direction of flow. All valves shall be complete with:-graduated position indicator (located in a visible place for the operation).Adjustable mechanical stop limiting devices to prevent over travel of valve disk in open and closed position.

Valves shall have integrally cast supporting feet.

2.1.22. ACTUATORS OPERATED VALVES

Actuators will be with Limit and Torque switches for either end of travel for control and interlocking purpose.
The characteristics of the actuators to be located on the valves are indicated in the actuators specification.
Should the actuator be located on the control column, all connecting accessories shall be supplied (extensions, joints, articulations, etc.). The valves 350Nb and above shall also be provided with hand wheel drive arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disk in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches shall be enclosed in water tight enclosures along with suitable space heaters.

MATERIALS / DESIGN DETAIL

Materials, design and other specific requirements of various categories of BF valves shall be as indicated below.

Sl. No.	Description	Requirement.
a)	Design	As per IS 13095/ BS 5155
b)	Type	Double flanged
c)	Material	
	i) Body and Disc	Cast steel grade ASTM-A 276 74 d Gr.WCB or SG Iron as per IS 1865 gr. 500/7
	iii) Shaft	Stainless steel AISI: 431
	iv) Body Seat	Monel 60 integral
	v) Disc Seat	EPDM
	vi) Bearing	PTFE LINED ST.ST.
	vii) Testing	AWWA-C-504/ IS
	viii) Other Requirement	Tight shut off

SPECIFIC PERFORMANCE GUARANTEE

For the rubber seated valves, the Contractor shall guarantee that in the closed position and with a disc differential pressure as specified the valves shall be water tight.

The Contractor shall guarantee that the operating mechanism shall open and close the valve under the specified maximum differential pressure within the time specified.

The valve shall be suitable for frequent operation during initial commissioning operation after a long period of inactivity.

MARKING

The mark stated by the Employer in the Material Request shall be printed on the body of all valves and relevant accessories (control columns and relevant connecting elements to the valve, counter flanges, valves for the auxiliary control if separately supplied, etc.).

The face of each hand wheel shall be clearly marked "Open" and "Shut" with arrows indicating the direction of rotation to which they refer. Each handwheel shall also be fitted with a circular name plate indicating the service for which the valve is intended and valve tag number. The name plates shall be engraved in black lettering.
Each spare part shall be individually marked with metal plates suitably punched for an easy identification.

TESTING AND INSPECTION

All valves shall be checked for correctness in respect of flange details as specified. The valves shall be tested as per the requirement of AWWA C-504 (latest version)/IS.Proof of design-tested valve shall not be supplied for the project.

For cast construction : Body and Disc shall be subjected to MPI/LPI and shaft shall be subjected to UT and LPI.

For Fabricated Construction: All Butt welds having thickness 20mm and above shall be subjected to Radiography and stress relieving. Only qualified welders shall be used for the purpose of carrying out welding. Shaft shall be subjected to UT and LPI.

Site Test

The valves shall be tested at site for opening and closing time, valve operation etc. The valve should operate without any flutter, noise, and vibration.

2.1.23. ACTUATORS FOR BUTTERFLY VALVES

DESIGN REQUIREMENTS:

- Electric actuators shall essentially consist of electric motors, limit switches, hand wheel and gear trains, mechanical position indicators, internal wiring and terminal block.
- The electrical actuator assembly inclusive of drive motor and unit switches compartment shall conform to IP 55 degree of protection.
- Actuators shall be sized so as to open / close the valve at the rated speed against the design differential pressure at 90% of the nominal voltage.
- Lost motion hammer blow feature shall be provided for seating / unseating the valve when the operating torque exceeds 11 kg/m.
- Operators shall be designed to be self locking (i.e. maintains the stem position) upon loss of electric power supply.
- Motors shall be installed on the operator prior to shipment to the valve manufacturer.
- Actuators shall be provided with lifting lugs for handling it along with the bonnet. Actuator assembly shall have all metal gear trains.
- Operators shall be flange mounted on the valve bonnet. Welding of operators onto bonnets is not permitted.

OPERATING SPEED:

All actuators shall have operating speeds as per the manufacturer's standard. However, this shall meet operating requirement of the system. Actuator operating times (opening and closing) shall be furnished with actuator details.

SERVICE CONDITIONS

i. The actuator shall be suitable for operation in a hot, humid and tropical atmosphere.

ii. Unless otherwise stated in the equipment specification, the ambient air temperature shall be taken as 50 dg. C, relative humidity 100% and mean sea level less than 1000 meters.

RATING

The actuator shall be designed for operation on a 415 V + 10%, 3-Phase 50 Hz + 5% solidly grounded system. The combined voltage & frequency variation shall be +/- 10%. The control circuit voltage shall be 240/110 V A.C. or 220V D.C.

The actuator shall be rated for three successive open-close operation of the valve or 15 minutes, whichever is longer.

The normal torque rating of each drive unit shall have adequate margin and at least equal to theoretical brake torque required to drive the equipment under full load, including all losses in speed reducers and power transmission.

The drive shall take into account valve operating speeds and differential and static pressures required for the service. The Contractor shall select operating speeds and design pressure to satisfy requirements of the equipment furnished and acceptable to the Employer. Motor actuator assemblies shall have all metal gear trains. Fibre gears are not acceptable.

PERFORMANCE

- The actuator shall open and close the valve completely and make lead-tight valve close, without jamming.
- The actuator shall attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).
- The actuator shall operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.
- The motor reduction gearing shall be sufficient to lock the shaft when the motor is de energized and prevent drift from torque switch spring pressure.
- The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

2.1.24. SPECIFIC REQUIREMENT

Construction

The actuator shall essentially comprise of the drive motor, torque/limit switches, gear train, clutch, hand wheel, position indicator / transmitter, space heater and internal wiring. The actuator enclosure shall be totally enclosed, dust tight, whether proof suitable for outdoor use without necessity of any canopy. All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficult.

Motor Drive

The drive motor shall conform to sub-section E2 of this specification.
The drive motor shall be three phase, 415V, squirrel cage, induction machine with class B insulation and IPW-55 enclosure, totally enclosed and self ventilated and designed for high

torque low inertia and reversing service suitable for operation at 50 deg. C ambient temperature. The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.
All motors shall have TEFC enclosures with space heaters to maintain the internal temperature above dew point when the motor is idle. Space heaters shall be rated for 240V AC. The motors shall be capable of operating the valve against the maximum load on the valve disc. with drive bearings in dry and dirty condition. Each motor shall be provided with two direct temperature-sensing thermostats to prevent thermal overload. All motors shall have O-ring seals to provide complete environmental protection when the motor is idle. Earthing terminals shall be provided on either side of the motor. Double shielded grease pre-lubricated, regreasble, antifriction bearings having a minimum life rating of 1,00,000 hours shall be furnished.

Limit switch

Position Limit Switches:
Each actuator shall have rotary drum position limit switches, two (2) for open and two (2) for close position, each with adjustable setting between fully open and fully close positions. Each rotary drum position limit switch shall have two normally closed (NC) and two normally open (NO) independent contacts. The adjusting mechanism for the limit switches shall be easily accessible.

Torque limit switches:
Each actuator shall have two torque limit switches with suitable arrangement to limit the opening / closing thrust. The torque switch, actuated by the torque clutch when the valve is restricted during opening / closing shall stop the motor thereby protecting the motor from overloading torque. The torque switches shall be set as near as possible to the pull out torque of the motor without damaging the valve of the operation.Each torque switch shall have two normally open (NO) and two normally close (NC) independent contacts. The torque limit switch adjusting mechanism shall be easily accessible.Limit switches along with all necessary electrical wiring shall be housed in a weather proof NEMA-3 enclosure and shall have gasketted cover and space heater to maintain the temprature above dew point. Each torque / position limit switch shall have 2 No + 2 NC potential free contacts. Contacts shall be rated to make and carry continuously 10 A at 110 V AC and 0.5A (inductive) 220 V DC.
Manual operation: All actuators shall have mechanically independent manual drive arrangement with hand wheel and motor declutching mechanism. The manual drive shall be provided with clutch and gearing as required to limit hand wheel effort to 25 kgt maximum along with suitable latch and locking arrangement to keep the hand wheel in engaged position using manual operation. The hand wheel shall disengage automatically during motor operation.

Position indicator/Transmitter: All actuators shall have one (1) built-in local position indicator for 0-100 % travel. All actuators shall be provided with mechanical 3-point dial position indicators. Rising steam valve shall additionally have visual position indication through plastic stem covers. Where required, valves shall be provided with continuous remote position indicators of the potentiometric type. The available voltage sources for the potentiometric position transducers are 220V DC and 240 V AC. The tranducer shall be suitable for stablished 4-20 mA current signal. The associated wiring for the transducers shall be housed in the limit switch compartment.

Space Heater: A space heater shall be included in the limit switch compartment suitable for 240 V AC, 50 Hz supply 220 V DC.

Wiring: All electrical devices shall be wired up to and terminated in a terminal box. The internal wiring shall be of sufficient size for the power rating involved but no case less than 1.5mm copper. All wiring shall be identified at both ends with ferrules. Internal wiring diagram shall be neatly pasted on the rear side of the terminal box cover. Motor power, heater and all control wiring shall be wired at shop to suitably rated master terminal blocks located within the limit switch compartment. All internal wiring shall be of 650/1100 V grade flexible standard copper conductor cables with tropical fungicidal treatment and the insulation shall be flame resistant. The limit switch terminals should be capable of terminating two nos. 2.5 mm copper cable. Terminal boxes shall be provided with removable undrilled gland plates to terminate following sizes of cable.

. I) 1 no. - 14 core 2.5^2 (Cu)
ii) 1 no. -10 cores - do -
iii) 1 no. - 2 pair
iv) 1 no. - 10 pair
v) 1 no. - Power cable

Terminal Box

Actuator terminal box shall be suitable to receive and terminate the following cables:
a) 1 No. power cable details of this shall be intimated later.
b) 3 Nos. 19 C x 2.5 copper conductor PVC insulated unarmoured control cable.

Actuator terminal box shall be provided with a removable front cover plate, and an undrilled detachable gland plate.

Data to be furnished: Motor data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque / limit switch contact development.

2.1.25. HYDRAULIC OPERATED VALVE (DISCHARGE VALVE) FOR FULLY CLOSING AND OPENING FUNCTIONS DURING STOPPING AND RUNNING OF PUMP

Type and description

Each pump shall be provided with oil pressure operated butter fly valve or through flow type valve, and oil pressure operated needle valve or sluice valve as by pass use. The valve shall have maximum capacity to allow maximum flow of pump discharge. The valve shall be designed to withstand the maximum transient pressure and shall be free from vibration and abnormality under the whole operating range of pump including any transient conditions of operations. The inside diameter of the valve shall be recommended by the bidder. The valve shall be so designed as to be capable of closing from fully opened position under the condition of maximum flow at every head with minimum oil pressure supplied to servomotor.

The opening and closing time of the valve shall not be more than 60 seconds including the operating time of bypass valve with normal operating pressure.

Amount of leakage passing through the gaps shall not exceed 5 litres/min. under a static head of 9.00 M including leakage through the bypass valve.

Valve Body

Valve body shall be fabricated of rolled steel plate welded structure or made of steel casting, and shall be sectionalized if required to suit transportation limitations if any. Each section shall be jointed at site by flange and bolts with sufficient strength to with stand the maximum hydraulic pressure of 100m. as well as to withstand the maximum static head without any distortion or deformation. Both ends of the valve body shall be provided with grooves for grease lubrication.

The bearings shall be provided with necessary packing glands to prevent inflow of sand or other foreign material contained in the water.

The valve shaft shall be horizontal type and the bearings shall support the full weight of the valve disc and shaft, and assure smooth opening and closing operations. The bearings shall be suitable for lubricating with grease from the grease supply device. All bearings shall be so constructed that the replacement of the liner and packing can easily be carried out.

The joint between the valve and the spiral case shall be made by flanges packing and shall be free from any leakage. The contractor shall furnish all the bolts, nuts, packing and other necessary material and bolts for making perfect tightness of the joint. Necessary connecting pipes, flanges, bolts, nuts, packing and other required parts shall be furnished by contractor. The valve body shall be provided with a set to mount the bypass valve.

Valve Disc

The valve disc shall be made of carbon steel casting or fabricated of rolled steel plates. The disc shall be designed with sufficient strength not to cause any distortion or deformation nor to cause any abnormal vibration when the valve is in open position or during operation. The disc shall be supported by forged steel turnions through the disc. on the peripheral surface of the disc a rubber ring shall be provided to seal off leakage together with a stainless steel seat provided on the valve body inner surface. The rubber ring shall be firmly fixed to the valve disc by metal fitting. The fitting bolts shall be made of stainless steel. The design shall fabricate easy renewal of the rubber ring on the spiral case side with the valve in its position. And also a maintenance seal shall be provided so that the seal replacement can be carried out without emptying the delivery line in case the regular seal is not effective.

Bypass Valve

Bypass valve shall be designed to assure the least amount of corrosion due to cavitation and cause the least noise or vibration during operation.
Metal sealing shall be provided to obtain a leak-proof seal when the valve is closed. The operation shall be provided to obtain a leak-proof seal when the valve is closed. The operation of the bypass valve shall be carried out by oil pressure commonly used for discharge valve. One end of the bypass valve shall be connected to the seat provided on the discharge valve body and a manual gate valve shall be provided on upstream of the hydraulic operated bypass valve. The valve shall be of such construction to permit easy manipulation by one man. The other end shall be connected to the seat provided. The valve shall be made of stainless steel.

Connection to Pipe to Delivery Line

In order to facilitate erection of the discharge valve, connecting pipe between the discharge valve (H.O.P.D / E.O.P.D) and the delivery line shall be furnished. The connection pipe shall be fabricated with rolled steel connection between delivery line and connecting pipe at a suitable distance away from the pump center line shall be done by welding at site.

Specifications of material for connecting pipe shall be determined during detailed engineering stage. Particulars of the connection shall be decided after award of contract. The connecting pipe shall be provided with pipe seats and taps for delivery line drain, pressure gauge pipe etc. The location and inside diameter of those pipe seats and taps shall be decided during detailed engineering stage.

Discharge Valve Operating Mechanism

Discharge valve operating mechanism shall consists of servomotor, rod, link and lever. The cylinder and head of servomotor shall be made of carbon steel casting or rolled steel for welded structure. The servomotor piston shall be made of carbon steel casting or cast iron. The operating mechanism, including that for the bypass valve shall be provided with manual locking devices which can lock both the inlet and bypass valve when they are closed. When the valve is locked, both opening and closing operation by oil pressure shall be blocked.

Operation of the valve shall be such that ,in opening, the bypass valve is opened first and the discharge valve shall be opened after the delivery line is filled with water and in closing, the discharge valve is closed first and the bypass valve is closed after the discharge valve is closed.
The bypass valve shall be provided with a hydraulic oil distribution valve to establish a condition to open or close the discharge valve in conjunction with the operating.

Two limit switches shall be provided for the discharge valve. Each limit switch shall be provided with two normally open auxiliary contacts and two normally closed auxiliary contacts.

A scale plate and a needle shall be provided to indicate the discharge valve position in percentage of 100 , when the valve is fully open.

OPU system for discharge valve shall be complete in shape and quantity and shall cover oil Pressure oil pumps valves.

Oil Pressure Unit System for Main Discharge Valve

A) **Oil Pressure Vessel**

i)The oil pressure tank shall be designed and tested in accordance with the ASME code (Section-VIII), for unfired pressure vessels or any other approved equivalent code considering the maximum working pressure of the system. The interior surface of the pressure tank shall be coated with oil resistant paint or other suitable coating to prevent deterioration of the metal. It shall also be ensured that oil characteristics in regard to its functions are not affected chemically or otherwise.

ii)The capacity of the oil pressure vessel shall be sufficient to meet all the pressure oil requirements of the servomotor and even below pump shut down oil level. It shall have an oil volume capable of performing three full operations that is close-open-close, with the oil pumps being out of operation.

iii)Means shall also be provided to prevent entry of air into the oil piping system under conditions of lowest oil level in the sump tank or receiver.
iv) The oil pressure vessel shall be provided with the following safety / control / operation switches:

a) Pressure switches for automatic starting of oil in flow into the OPU receiver when oil pressure in the vessel falls below a predetermined value and for automatic stopping of oil inflow when pressure rises above a predetermined value, and for alarm and trip under low pressure or abnormally high pressure conditions. Necessary unloader valves shall be included in scope of supply.
b)Level switches, differential pressure switches for giving alarm and shutting down the pumps when oil level falls below predetermined value.
c) Level switch / differential pressure switches for giving alarm when oil level rises above the predetermined value.
v)The oil pressure vessel shall be equipped with a float type dial gauge for indicating oil level in the tank.
vi)The oil pressure vessel shall be complete with compressed air inlet, auto air replenishing system, air relief valve (safety valve), pressure gauges, piping, oil drain connections with valve, manhole, etc.

Oil Sump-Tank and Pumps

i)Two nos. screw type oil pumps shall be provided and located on the tank top itself, one serving as main and other as standby, with a manual selector switch to changeover their functions. The standby pump shall automatically start on failure of the main pump in service.

ii) The pumps shall be of continuously running type with adequate capacity during unit running time, with pressure switch control and shall continue to run intermittently with pressure switch control, when the unit is shutdown. A set of smoothly operating unloader valve, non-return valve and safety valve shall be provided to regulate the oil level.

iii) The pump motors shall be of continuous rated and shall be provided with 415V, 3 Phase, 50 Hz. squirrel cage induction motors.

iv)Oil sump tank shall be provided with float type dial level indicator, oil contamination detector, level switches for low/high oil level alarms, oil filter, air vent and filter, oil inlet/ outlet connection and drain valves etc. The interior surface of the sump tank shall be coated with oil resistant paint or other suitable coating to prevent deterioration of the metal. It shall also be ensured that oil characteristics in regard to its functions are not affected chemically or otherwise.

v)The sump tank provided shall have a sufficient capacity with not less than 50% margin to hold all the oil in the system.

vi)The sump tank shall be provided with a manhole for access to interior of the tank and shall have suitable connections for oil purifier.

vii)The sump tank shall be provided with oil level gauge and oil level switches for indication of oil level low/ high and alarms.

LEAKAGE OIL TANK AND PUMPS

Oil leakage tank with screw type pumps and necessary piping and valves shall be provided and located at suitable location. The tank shall be provided with suitable float type dial level indicator level switches for automatic start/stop of the pumps. The pump motors shall be suitable for 415 V, 3 phases, 50 Hz, AC supply. An alarm shall also be provided to indicate high & low oil level in the tank.

DISCHARGE VALVE OIL PIPING AND VALVES

Oil piping and valves complete with flanges, bolting materials, gaskets; packing etc. required for inter-connections between the various equipment shall be included in the offer. All piping shall be steel, suitable for maximum oil working pressure. All valves shall be cast or forged steel valves having flanged ends.

EOPD:

EOPD Shall be electrically operated gate valve and shall be provided and limit switches end limit switches, torque switches along motors of suitably rated with terminal block arrangements. The cable sizes shall be as detailed above.

INSTRUMENTATION AND CONTROLS FOR PUMP AND PUMP CONTROLLER.

Instrumentation, alarms, safety devices and controls necessary for automatic control, monitoring and efficient operation of the pump with its associated equipment shall be supplied by the manufacturer so as to constitute a complementary part of the complete and coordinated set of such instruments, gauges, controls and safety devices required for supervision and controls of the unit during normal running and in emergencies.

Tentative requirements of the instrumentation etc. are given in the schedule of requirement. The Bidder shall however, offer any additional instruments and safety devices which the bidder considers, necessary for the unit and the bidder shall guarantee the sufficiency and adequacy of the provisions in this regard. The Pump-motor is normally started from the SCADA system in the control room and brought to synchronous speed and then synchronized with the grid and pumping of water is done. In general the instrumentation and control scheme shall be such as to provide for manual mechanical control, manual local electrical control and automatic remote control and emergency shut down. The local electrical control and emergency shut down from unit control panel(Local control panel) and the remote electrical control from unit control board / MMI panel to be mounted in the control room shall be provided.

All necessary indicating instruments, gauges and controls etc. for the pump and controller shall be mounted on the unit control board and wherever necessary on unit control panel. All temperature indicating/recording instruments, associated relays, certain electrical instruments on the unit control board shall be provided by the manufacturer.

For remote control of the units from the main control room, all necessary items of the controller and also alarm/safety devices shall be provided on the main control panels in control room. The controller controls and indicating instruments shall be provided. The control which are provided both on the unit control board/Machine control panel and the controller cabinet (Main control Board) shall be so interlocked electrically as to eliminate the possibility of simultaneous operation of any control from both the boards.

One set of apparatus for measurement and recording of the pump discharge shall be supplied with each pump. The apparatus shall be complete with all necessary instruments, peizometers, tapings, interconnecting tubing etc. and shall be calibrated at the time of efficiency and out-put tests on the pump.

One set of pressure transducer type water level transmitter and indicator/recording instrument shall be provided for cistern. The signal for the head variation should be transmitted to the gate opening limiter of the controller. This device shall be able to prevent operation of pump at non-rated duties restricting extra gate openings at higher heads.

SPECIAL TOOLS, SLINGS, CONSUMABLES ETC.

All special tools, slings, lifting devices, jacks, turn-buckles, foundation plates, bolting materials etc. required for assembly, erection, dismantling of the pump, controller and other equipment of bidder's supply shall be included by the bidder. A list of the special tools and equipment required for assembly/erection and maintenance of pump components as listed in "Schedule of Requirement", item-4 shall be supplied. First filling of the controller and lubrication oil with 10% spare capacity, for pump shall be supplied by the manufacturer and the brand and grade of the oil shall be specified.

SPARES

Spare parts for the pump, controller equipment and instrumentation as listed in item 2 schedule of spares of this section shall be supplied along with the main equipment. All spare parts supplied shall be interchangeable with and shall be of the same material and workmanship as the corresponding parts of the equipment. The spares shall be supplied along with the first unit. The bidder shall also indicate additional spares considered essential by him for five (5) years normal operation and maintenance.

TESTING DEVICES AND INSTRUMENTS FOR TESTING DURING ASSEMBLY, ERECTION AT SITE AND FOR FIELD ACCEPTANCE TESTS

Testing tools and equipment required for testing during assembly/erection at site and all instruments and devices required for field acceptance tests for fulfillment of efficiency and output guarantees, shall be supplied.

SHOP ASSEMBLIES AND TESTS

The first pump shall be completely assembled in shop and properly match-marked and dowelled to ensure correct assembly and alignment in the field except that where necessary suitable dowels shall be furnished for insertion after field assembly and drilling.

In the case of subsequent pumps, part assemblies to the required extent shall be done and match marked to avoid any problem of matching during erection at site.

The equipment such as pressure tank, gate, servomotors, piping, coolers etc., which shall be subjected to oil (or water) pressure shall be shop tested as a pressure equal to 150 percent of the maximum operating oil (or water) pressure inclusive of maximum water hammer in such equipment.

The bidder shall give a list with details of the shop assembly tests to be performed on the components of the pump such as runner, guide bearing etc. including controller and other accessories etc. These shall be subject to the approval of the purchaser.

The purchaser or his authorized representative shall have access to the manufacturer's works for all purpose of witnessing the manufacture, Inspection of various assemblies and for testing of all components. The equipment shall be assembled and shop tested in the presence of the purchaser or his authorized representative, prior to dispatch. Any work found defective or unsatisfactory shall be rejected.

The bidder shall conduct non-destructive tests on components of pump.

FIELD ACCEPTANCE AND OTHER SITE TESTS

Hydraulic pressure tests, leakage tests and operation tests where applicable shall also be performed on components such as the pump components, pressure tanks, controller , sump tank, pumps, motors etc.
The manufacturer shall furnish a list of all the field tests to be performed during site assembly and erection of the pump prior to commissioning.
Field Acceptance tests shall be performed on the fully erected pump-motor units to determine the actual performance of the unit vis-à-vis the guaranteed performance. The field acceptance test shall be performed as per IEC test code for Hydraulic pumps or any other equivalent standard.

The pump shall be given a over speed test for a period of 15 (fifteen) minutes to demonstrate their ability to withstand successfully the mechanical stresses and hydraulic performance incident to maximum runaway speed at an effective maximum head with wicket gates fully open. The cost for any component replacement/rectification that may be required shall be to the account of manufacturer.

DRAWINGS, DATA, MANUALS ETC., AND DOCUMENTATION TO BE FURNISHED BY THE BIDDER

The bidder shall furnish all drawings, data, manuals and other necessary literature in six copies. The Bidder shall, in addition, supply the documentation for the design and manufacture of the pumps as given below:

I. Supply of complete information on Scheme design including basic data on Scheme information, model test report, characteristic curves etc. for operation.
II. Supply of detailed design drawings and calculations, strain gauging results, computer programmes, plate development data for draft tube assembly, dimensional tolerances particulars
III. Complete specifications of materials. Copies of specifications relating to inspection and testing of material and finished components
IV. Detailed manufacturing drawings for various pump components and information.
V. Tooling information.
VI. Recommended list of suppliers for supply of components.
VII. All information necessary for co-ordination of station and control equipments.
VIII. Drawings clearly showing the various components/ assemblies of the pump, governing equipment draft tube etc. in plan and elevation.
IX. Layout drawings of the pump house both in section and plan showing the overall dimensions and layout of the pumps, auxiliaries, general run off pipes etc. clearly indicating unit spacing dimensions of draft tube etc. and all important elevations.
X. Comprehensive operation, maintenance and installation instructions along with O&M manuals of all bought out items.
XI. Supply of dimensional drawing of all the vital hydraulic passages. No load to full load pump performance curves, efficiency and cavitation characteristic curves. Plant and machine sigma curves for pump operation.
XII. A complete list of equipments, Auxiliaries etc. covered in the offer.
XIII. Schematic drawings for electrical controls, instrumentation and Hydraulic controls.

XIV. Physical and schematic drawings and descriptive literature on the Pump controller and control mechanism.

XV. The bidders shall furnish all the data, especially guaranteed and other technical particulars called for in the schedules and also include their experience in the manufacture, erection, testing and commissioning of pump giving details of their technical particulars. Any offer lacking complete information in this respect is likely to be rejected.

(bb)

TRAINING OF EMPLOYER'S ENGINEERS

The bidder shall arrange training for 6 engineers of the purchaser for a period as mutually agreed upon during the design and manufacture of the pump at the manufacturer's design and drawing office and manufacturing shops to familiarise with all aspects of design and manufacture of , associated auxiliaries, control systems etc. All expenses including to fro, lodging and boarding charges for training the engineers of the purchaser shall be borne by the bidder.

COMPLETENESS OF EQUIPMENT

All the fittings and accessories of the pump and associated auxiliary and ancillary equipment though may not have been specifically mentioned in the specification but are usually necessary for completeness of the above equipment shall be deemed to be covered by the specification and shall be indicated and furnished by the bidder with out any extra cost to the purchaser.

DEVIATIONS FROM SPECIFICATIONS

The deviations from the specification shall be listed in the Annexure A, absence of which it shall be presumed that the provisions of specifications are completed with by the bidder.

SCHEDULE OF REQUIREMENTS

Item No.1. pump

I. suitable type pumps each for discharging not less than of water and each pump comprising with the following.

II. One runner of stainless steel and cast steel boss complete.

III. One shaft of forged electric furnace steel properly heat-treated and forged with connecting flanges at both ends, keys coupling bolts, nuts, covers etc. for connecting to the runner and to the auxiliary shaft and motor rotor.

IV. One Set of guide bearing of oil-lubricated type with bearing housing and with temperature detector, temperature detection relay, oil piping, pressure gauges, cooling water piping, water flow indicators differential pressure relay and other accessories.

V. One Stuffing box with sealing water piping, differential pressure relay, and water flow indicators, for alarm annunciation in U.C.B. and local indication.

VI. One Draft tube of steel plate suitably sectionalized and equipment for assembly of sections access door with hinged cover and provision for connecting to discharge ring.

VII. One Set of embedded piping including leakage water drain piping, pump sets and other miscellaneous piping.

VIII. One Discharge ring with a provision for connecting to the draft tube on one side and to the guide vane supporting cover on the other side with necessary connecting bolts etc. A manhole with bolted cover for access shall be provided in the discharge ring.

IX. One Stay ring of cast steel or welded plate steel, which shall be embedded in the concrete.

X. One Inner stay vane welded with stay column and one outer stay vane with drain piping, peizometer tapings.

XI. One controller (controller) equipment comprising motor drive, gate control arrangement etc. with a complete set of instrumentation, controls, and automatic safety devices, mounted on the actuator and at the Unit Control Board and equipment for necessary remote control and indication at the main control board.

XII. One Discharge valve with oil pressure system for control, comprising oil pressure pumps, driving motors complete with starting equipment, instrumentation and automatic controls, oil piping, necessary stop valves, check valves, blow off valves, by pass valves, unloading valves, safety valves, fittings etc. and arrangement for replenishment of air in the oil pressure receiver including compressor plant etc. valves (H.O.P.D and E.O.P.D)

XIII. One Speed indicator motor.

XIV. One complete system of equipment, piping, connecting pipes, valves, bends, drains etc. for cooling water, oil and High-pressure compressed air systems for pump and controller equipment.

XV. One complete system of draft tube, drainage and dewatering system.

XVI. One Set of water level indicator for indication of cistern water levels which are common to all the three units with instruments/transmitters, sensing element, piping, valves, complete system for monitoring the reservoir level. The wells for water level sensors and wiring materials between each equipment shall be supplied.

XVII. Two Sets of erection tools common to all the three units.

XVIII. One Set of special tools, slings and consumables etc.

XIX. One Set of tools and plant for maintenance of the plant to be provided immediately after commissioning of pump-I for operation & maintenance.

EXPANSION JOINT / DISMANTLING JOINT

2.1.26. GENERAL

Expansion Joint will be provided in the discharge piping as shown in the G.A. drawings enclosed with this tender.

2.1.27. CODES AND STANDARDS

The design, manufacture and performance of metallic expansion joints shall be as FSA, USA or equivalent standard and comply with or all currently applicable statues, regulations and safety codes in locality where the equipment will be installed. The equipment shall also conform to the latest editions of fluid sealing association.

2.1.28. OPERATING CONDITIONS AND DESIGN REQUIREMENTS:

For operating conditions and design requirements refer to design data sheet enclosed.

2.1.29. CONSTRUCTIONAL FEATURES

All parts of expansion joints shall be amply proportioned for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient conditions.

The expansion joints shall be single bellow metalic expansion joints. The arches of the expansion joints shall be filled with soft metalic.

The design shall be suitable for the pressures and type of fluid i.e. raw river water.

The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic metallic of adequate hardness. The shore hardness shall be less than 50 deg. A for outer and 50 deg. A for inner cover.

The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the wave. The fabric plies shall be impregnated with age resistant metallic or synthetic compound and laminated into a unit. Reinforcement, consisting of solid metal rings embedded in carcass, shall be provided.
Expansion joints shall be complete with stretcher bolt assembly to absorb piping movements and accommodate mismatch between pipelines.

Main Body

The expansion joints shall be of heavy-duty construction made of high-grade abrasion resistant natural or synthetic metalic compound. The basic fabric for the “duck” shall be either a superior quality braided cotton or synthetic fiber having maximum flexibility and non-set characteristic
Note: Slip type metallic joint should be provided with relevant specifications instead of metallic expansion joint.

Reinforcement
The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

Retaining Rings
All expansion joints shall be provided with stainless steel retaining rings for use on the inner face of the metalic flanges, to prevent any possibility of damage to the metalic when the bolts are tightened. These rings shall be of split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end metalic flanges and shall be in two or more pieces. The split retaining rings shall be of 10 mm thick stainless steel of tested quality. Steel washers shall be provided at the boltholes where retaining rings are split.

End Flanges
The expansion joints shall be integral fabric reinforced full-face metallic flanges. The bolt hole on one flange shall have on eccentricity in relation to the corresponding bolt hole on the

flange on the other face. The end metallic flanges shall be drilled to suit the companion pipe flanges.

Outer Cover
All exposed surfaces of the expansion joints shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters porosity and other surface defects

Control Units
Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretches bolt washers, nuts and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.

Expansion joint tag no. & name plate
Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features which will be indicated by the engineer in the expansion joint drawing submitted for his approval by the Contractor.

2.1.30. TESTING FOR METALIC EXPANSION JOINTS

Manufacturer's standard test shall be performed during manufacture and after the completing the manufacturing. Tests shop shall include but not limited to the following.

All bear bellows shall be subjected to deflection test under pressure, pressure being raised from zero to design pressure in regular steps and deflection measured at each step.
(cc)
Material test shall be conducted as given below:
(dd)
a) Metallic compound test slab after vulcanizing shall be tested for tensile strength, elongation and hardness.
b) Fabric strength of synthetic fibre for reinforcement shall be checked and test for metalic to fabric, metallic to metal adhesion shall be carried out. Test on metallic shall include hydraulic stability check as per ASTM D- 471.

2.1.31. VACUUM TEST

All expansion joints shall be subjected to an absolute internal pressure of 25 mm Hg. The test shall be conducted in three different positions for a minimum period of thirty (30) minutes duration in each position.

Immediately after the vacuum test, a hydraulic test, as per the relevant, standards shall be conducted on the expansion joints. The rate of pressure duration the test shall not be less than 1 bar/ second. The hydraulic tests shall be conducted on the expansion joint in three different positions for duration of 30 minutes (minimum) in each position.

Either during the hydraulic test or during the vacuum test, the expansion contraction or deformation shall not be move 1.5%. However, a cumulative error is not allowed. The purpose of conducting hydraulic test or vacuum test is to ensure the stability to withstand deflection in axial and transverse direction.

Twenty four (24) hours. After the above test, the permanent set (variation in dimensions with respect to its original dimensions) shall be measured and recorded. The permanent set shall not be more than 0.5%.

Test Results
The record of the test results to establish the tensile strength, permanent set hardness and adhesion characteristics of the metalic used in the construction of the expansion joint shall be made available to the engineer for his approval.

2.1.32. SHOP INSPECTION

The surface of the expansion joints shall be examined by the engineer and/or his representative and abnormalities, if any, noted**.** The Contractor shall arrange training on the equipment supplied for engineers of the purchaser , as mutually agreed upon during the design and manufacture of the equipment to familiarise with all aspects of design and manufacture of Pumps, associated auxiliaries etc. All expenses like living, traveling and other expenses of the trainee engineers of the purchaser shall be borne by the Contractor. The supplier shall also arrange and meet the expenses of stay of Engineers of the purchaser for witnessing the Model Tests

AC MOTORS FOR VFD

2.1.33. SCOPE

The scope covers design, manufacture, testing at manufacturer's works before dispatch, supply, erection at site, testing and commissioning of motors of **suitable** capacity each complete with associated auxiliary equipment like VFD. and other ancillary equipment, like cooling water, associated piping and valves, necessary instrumentation, controls, safety devices etc. and spares as well as special tools and plants for pumping station as described in this specification and annexed schedule of requirement. The scope of supply shall also include all parts, accessories, and spares etc., which are necessary for erection, operation and maintenance of complete motors for **five** years, even though they are not individually or specifically stated in the specification. Corresponding parts of the motors, associated equipment and spares shall be of same material, dimensions workmanship and finish and shall be interchangeable.

Class of Insulation: The ac motors for VFD application shall have windings of class `F' insulation with temperature rise limited to class B unless otherwise specified [see 'IS 1271:2012 'Electrical Insulation – Thermal evaluation and Designation']

2.1.34. RATED VOLTAGE, FREQUENCY AND PERFORMANCE VALUES

Voltage and Frequency Variation - The motors shall be capable of delivering the rated output withThe terminal voltage differing from its rated value by not more than +6%, -10% in general cases but in special cases if desired by the purchaser.

The frequency differing from its rated value by not more than +3 /-3% in general cases but in special cases if desired by the purchaser, frequency fluctuation of +3% / -6% shall have to be provided, or

Any combination of (i) and (ii).In the case of continuous operation at extreme voltage limits, the temperature-rise limits specified in Table-1 of IS 325:1996 shall not exceed by more than 10oC. Motors, when operated under the extreme conditions of voltage and frequency variation, may not necessarily have their performance in accordance with this standard.

The motor shall be suitable for operating in the frequency range as per requirement with corresponding voltage variation for obtaining rated torque when used for variable speed application.

The motor shall be suitable for direct-on-line starting for non-inverter application. The starting current shall be limited to max. six times the full load current.

The motor shall be suitable for operation in all respects and shall deliver the rated output over the rang of voltage and frequency variation as specified above.

Each motor shall be star connected and the main and neutral leads shall be brought out of the stator frame for insertion of current transformers for protection and metering and surge protection apparatus. The motor shall be grounded though a Resistance grounding device to limit the ground fault current to less than 10 (ten) Amps.

The moment of inertia of the motor shall be coordinated with pump parameters, to meet the requirement of pressure and speed rise as specified in Section-I. The inertia constant shall preferably be not less than 1.5. The flywheel effect shall be built into pump-motor and not added in the shape of weights.

TYPE OF ENCLOSURE : The degree of protection to be provided by the enclosure shall be IP 55 of IS 4691:1985 `Degrees of protection provided by enclosures for rotating electrical machinery (first revision)' or better as required by the purchaser.

METHOD OF COOLING : The method of cooling used shall be IC 0041(fan cooled) / IC 43(separately powered force cooled by fan) / IC411(TEFC)/IC 416(A), IC416R in accordance with IS 6362:1995 `Designation of methods of cooling of rotating electrical machines'. In case of separately cooling motor, the motor speed is to be limited to 1500 rpm (synch).

MOUNTING : The mounting shall conform to any one of the designations IMB 3 ,IMB 5, IM 1001, IM3001 specified in IS 2253:1974 `Designations for types of construction and mounting arrangement of rotating electrical machines (first revision)'. If specified, hollow shaft extension may be provided according to the drawing provided by the purchaser

2.1.35. CORRECTION FACTORS FOR TEMPERATURE

Ambient temperature deg C	**Output correction factor%**
55	80
60	75

The motors shall also be suitable for operation on direct online starting.

The motors shall be suitable for type of duty S4, S5, S6 and S7 as specified in IS 12824:1989 `Type of duty and classes of rating assigned to rotating electrical machines [withdrawn]'.

Motor shall be suitable for Total harmonic distortion of 5%.

2.1.36. EFFICIENCY AND OUTPUT GUARANTEES

EFFICIENCY GUARANTEES: The efficiency of the motor at full discharge of pump shall be above 95% percent at the rated voltage and power factor and combined efficiency shall be above 85%. The weighted average efficiency shall be stated and guaranteed. The above efficiencies shall be subject to penalty and rejection as defined in clause 1.4.5

DETERMINATION OF EFFICIENCIES: The efficiencies shall be determined by summation of losses method in accordance with the latest issue of IEC: 34-2 or IS: 4889. The static excitation equipment losses shall also be included in the motor losses. No tolerance in the quoted efficiency for guarantee purposes shall be permitted.

OUTPUT AND TEMPERATURE RISES:The motor shall be guaranteed to be capable of giving its rated output and maximum output without exceeding the temperature rises.

2.1.37. PENALTY FOR SHORT-FALL IN EFFICIENCY AND OUTPUT:

While testing each pump-motor, for any short-fall in the tested values of rated output, maximum output and weighted average efficiency from the guaranteed values, penalty shall be applied Rs.2,50,000 (Rupees two lakhs fifty thousand only) for each 0.01%(one hundredth percent) by which the test figure is less than the corresponding guaranteed figure.

The penalties on account of shortfall in output and the efficiency shall be computed separately and the total amount of the penalty shall be algebraic sum of these two.

No tolerance shall be permitted over the test figures of output. Tolerance in computation of losses for determining efficiency shall be allowed in accordance with IEC.

2.1.38. REJECTION LIMIT:

The purchaser has a right to reject the motor equipment if the test values of either of the maximum output or the weighted average efficiency is less than the corresponding guaranteed value by 3 (three) percent or more.

The motor is also liable for rejection if either of the stator or rotor winding temperature exceeds the specified limits while operating corresponding to maximum output. This guarantee shall be without bonus in case of temperature raises being less than those specified

2.1.39. DIMENSIONS

The basic dimensions of foot-mounted and flange mounted ac roller table motors and their shaft extensions shall correspond to IS 1231:1974 `Dimensions of three-phase foot-mounted induction motors (third revision)' and IS 2223:1983 `Dimension of flange-mounted ac induction motors (first revision)' respectively.

2.1.40. SPECIAL CONSTRUCTIONAL FEATURES

Material of Body - Material of the motor body shall be cast iron grade FG-260 conforming to IS 210:2009 `Specification for grey iron castings (fourth revision)', or SG iron conforming to IS 1865:1991 `Specification for iron castings with spheroidal or nodular graphite (second revision)' or fabricated steel conforming to IS 2062:2011 `Hot rolled medium & high tensile structural steel'. Non ferrous material for motor body is not acceptable.

For foot-mounted motors with cast iron / Spheroidal Graphite iron body, the feet shall be integrally cast with the body.

Separately screwed eyebolts or lifting lugs of suitable sizes shall be provided on the motor for the purpose of lifting. Eyebolts conforming to IS 4190:1984 `Specification for eyebolts with collars' shall be used.

Shaft Extension - All motors shall have a single shaft extension unless otherwise specified.
Bearings - All bearings shall have an L10 life of at least 40000 h according to IS 3824:2002 `Rolling bearings – Dynamic load ratings & rating life.' The bearings shall be selected so as to take care of the thrust to which the motors are likely to be subjected. The actual thrust value shall be indicated by the user.

Lubrication of Bearings – Re-greasing facility through a grease nipple conforming to IS 4009(Parts 1 & 2):1981 `Specification for grease nipples (first revision)', along with facility for excess grease removal shall be provided for motors of frame sizes 200 and larger.

The provisions of the terminal box shall be in accordance with clause 5 of IS 1231:1974. It shall be possible to turn the terminal box to any of the four positions at 90o intervals to permit cable entry from any of these four positions.

Interchangeability of Parts - The motors of identical rating supplied in a lot by the same supplier shall have the interchangeability in the following parts:
a) Rotors,
b) End shield,
c) Bearing capsules
d) Bearing cups
e) Self cooling fans.

2.1.41. EARTHING

Two separate earthing terminals of proper size suitable to receive galvanized iron conductor shall be provided on the bottom half of the motor body. In addition to the two outside earthing terminals, provision for one more earthing terminal inside the terminal box is to be kept. Size of earthing terminal shall conform to clause 12.2.2.2 of IS 3043: 1987 `Code of practice for earthing (first revision)'.

TEMPERATURE-RISE TEST
The temperature-rise test shall be carried out at full load in accordance with 22 of IS 325:1996 by subjecting the motor to the rated acceleration value (B). The permissible limits of temperature-rise shall not exceed the relevant values given in Table-1 of IS 325:1996.

Temperature Rise Test Under Stalled Rotor Condition – The temperature shall be measured by applying rated voltage to the motor with rotor locked. The temperature-rise shall not exceed the permissible value for the relevant insulation class.

LIMITS OF VIBRATION

Limits of vibration intensity shall be in accordance with normal class of Table 1 of IS 12075:2008 `Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher – measurement, evaluation and limits of vibration severity.'

NOTE: The manufacturer shall indicate in the test certificate that rotor has been dynamically balanced with half key.

LIMITS OF NOISE LEVEL The noise level shall not exceed the limits specified in IS 12065:1987 `Permissible limits of noise level for rotating electrical machines', if required by the user

TERMINAL MARKING Terminals shall be marked in accordance with IS/IEC 60034-8 (2002) [in supersession to IS 4728:1975]. Identical markings shall be provided both on the leads and the terminal blocks.

RATING PLATE Rating plate made of stainless steel stating the following particulars shall be fixed on the body of the motor:
a) Reference to this interplant standard, i.e. IPSS:1-03-039-14
b) Rated output in kW,
c) Name of the manufacturer and trade mark,
d) Manufacturer's serial number and frame reference,
e) Rated voltage and winding connection of the motor,
f) Rated current in Amps. at rated voltage,
g) Speed in rev/min at rated output,
h) Rated frequency,
i) Class of insulation,
j) Type of duty,
k) Bearing designation,
l) Type of enclosure,
m) Mass of motor in kg,
n) Year of manufacture.
o) Motor suitable for VFD,
NOTE: An additional name plate may be used to indicate the designation of bearings, lubrication details (type, quantity and frequency).

TESTS : The tests applicable to the motors covered by this standard shall be in accordance with Table-2. A certificate indicating the routine tests conducted on each motor including thermal withstand capability shall be supplied with the motors. The manufacturer shall supply type test certificate with each order whenever required by the user.

MOTOR INSTRUMENTATION AND CONTROLS AND SAFETY DEVICES:

The supplier shall furnish all ancillary equipment relating to the motor as outlined under schedule of requirements. This equipment together with the other motor equipment supplied, shall constitute a complete and co-coordinated set of instruments, gauges, controls and safety devices for the supervision and control for the units during normal running and in emergencies. The instrumentation and controls of the units shall be provided on machine control panels/unit control panels and the main control board. The bidder shall provide equipment in accordance with schedule of requirements for mounting on these boards and locally on the equipment of his supply. The instruments and controls shall have to be suitable and adequate for manual control, automatic sequential control. The bidder may, however, provide any additional instruments, alarm control or safety devices that are considered necessary.

The unit control panels shall be supplied by the bidder. Indicating instruments, gauges, and controls for the motor as detailed in the schedule of requirements shall be provided by the motor manufacturer and shall be mounted on the unit control panel

SPARES:

Spare parts for the motors as listed in the schedule of requirements shall be supplied along with the first motor. All spare parts supplied shall be interchangeable, and shall be of the same materials and workmanship as the corresponding parts of the equipment. The bidder shall also recommend any additional spares consider essential for 5 years of normal operation

TESTS AT WORKS:

The first motor along with the excitation system and other auxiliaries shall be completely assembled at the manufacturer's works. The following tests shall be carried out on the motor at works in accordance with IS 4722/1968 and IEEE 115 or relevant IEC:

a) Temperature rise

The test shall be carried out in accordance with Indian Standards, IEC or any other equivalent standard.

b) Insulation Resistance Test:

The above test shall be carried out on all machines, both before and after high voltage test. The insulation resistance shall be measured between open windings and between windings and frame. The test for insulation resistance shall be carried out as prescribed in the "Guide for Testing Insulation Resistance of Rotating machines" - IS 7816 - 1975 or its latest revision.

c) Dielectric tests (on all machines):

The high voltage test shall be applied between the winding and the frame with the core connected to the frame and to the windings not under test. Connections between the windings (e.g. neutral point) shall be separated before making the tests. It shall be applied to the complete machine with all its parts in place under conditions equivalent to normal working conditions and shall be carried out at the manufacturer's works after the temperature rise test of the machine. The test voltage shall be alternating and shall be as nearly a sine wave as possible. Tan-delta tests shall also be conducted on specified number of coils in accordance with relevant standard.

d) Efficiency:

The efficiency of the motor shall be determined by the summation of losses method.

All the losses shall be measured in accordance with the approved standards.

f) Short Circuit Tests (in Works)

To verify the capabilities of the motor to withstand short circuit stresses without injury, short circuit tests shall be carried out.

g) Characteristics tests (In Works)

1) Direct axis transient time constants
   i)Open Circuit.
   ii)Short Circuit.
2) Direct axis transient reactance.
   i) Rated current
   ii)Rated voltage.
3) Sub transient reactance.
4) Negative phase sequences reactance.
5) Moment of Inertia of rotating parts (WR)
6) Short Circuit ratio.
7) Phase sequence tests.

TESTS AT SITE:

The following tests shall be carried out on the motors at site in accordance with IS

I. Dielectric Test: In case of motor already tested at the manufacturer's works, the dielectric test shall be carried out with 85% of the test voltage where as all other motors shall be tested at the full test voltage.
II. Determination of the resistance of armature and all field windings.
III. Phase sequence test.
IV. Temperature rise test
V. Visual inspection and wiring check.
VI. Insulation test voltage withstand test.
VII. Checking of control and relay logic.

TESTING EQUIPMENT:

Field-testing equipment required for testing of the equipment shall be supplied by the bidder.

SPECIAL TOOLS AND DRAWINGS:

All necessary special tools and devices such as lifting devices for motor. for erection and maintenance of the motor shall be supplied in accordance with the "schedule of requirements".

The following drawings and data shall be submitted by the bidder with in one month from the date of signing of contract.

I. The general drawings and overall dimensions of the motor showing position of main and neutral leads, important elevation etc.
II. Graphs showing predicted characteristics of the motor (capability Curve).
III. General layout drawings showing overall dimensions and layout and relative position of all auxiliaries, ducts spaces for cables and piping etc.
IV. Details of fire fighting protection -schematic diagram, literature, etc.
V. Start/stop sequence logic diagrams.
VI. Protection and Metering systems.

(ee)

PROGRAMME OF SUPPLY OF ENGINEERING INFORMATION:

Within six weeks of the effective date of the contract the bidder shall furnish The schedule of issue of documents and drawings.

A detailed scheduled listing out all major assemblies and critical parts and dates by which the related information shall be supplied should be appended to the bid.

The supply of above information should be in the form of CDs of all drawings along with one full size print of each drawing.

Twelve copies of the comprehensive, erection, operation and maintenance instruction books for the motor and its auxiliaries equipment should also be supplied, free of cost.

The bidder shall indicate requisite capacity, span, lift etc. in respect of E.O.T. crane required for installation and maintenance of the pump -motor units. These items are also in the scope of supply.

RESPONSIBILITY FOR SCHEME CO-ORDINATION:
The motor supplier shall be completely responsible for overall Scheme co-ordination comprising of the station layout, control schematics, and machine protection.

TRAINING OF ENGINEERS:
The bidder shall arrange training for 6 engineers of the purchaser for a period as mutually agreed upon during the design and manufacture of the motor at the manufacturer's design and drawing office and manufacturing shops to familiarise with all aspects of design and manufacture of , associated auxiliaries etc. All expenses including boarding and lodging , to and fro charges for training of engineers of the purchaser shall be borne by the bidder.

The supplier shall also arrange and meet the expenses of stay of Engineers of the purchaser for witnessing the Model Tests.

SCHEDULE OF REQUIREMENTS:
Item 1 (a) motors

vertical shaft 3 Ph., 0.415 KV, 50 c/s, 0.95 pf Lagging/leading induction motors of suitable capacity each, directly coupled to pump. Each motor shall consist of the following:
One Stator & Rotor consisting of stator core, frame (part of shell of steel plates) stator windings, space heaters with control switch, cooling ducts and other necessary accessories.
One set of vibration detectors.
One set of VFD The equipment shall be complete with suitable cubicles for housing external wiring, cables, etc.
The equipment shall be complete with suitable cubicles for housing external wiring, cables etc.
Fire Extinguishing Equipment: Two sets CO2 type fire extinguishing system

2.1.42. CODE & STANDARDS:

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards. The 12kV Package Substation Design must be as per IEC 62271-202.

The Package Sub-station offered shall in general comply with the latest issues including amendments of the following standards.

Title	**Standards**
High Voltage Low Voltage Prefabricated Substation	IEC:62271-202
High Voltage Switches	IEC 60265
Metal Enclosed High Voltage Switchgear	IEC 60298/ IEC62271-200
High Voltage Switchgear	IEC 60694
Low Voltage Switchgear and Control gear	IEC 60439
Power Transformers	IEC 60076

2.1.43. DESIGN CRITERIA

Package Sub-station consisting of **11kV Non-Extensible SF_6 Ring Main Unit with VCB as protection + Transformer + Low Voltage Switchgear** with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as **Outdoor substation** located at very congested places. The Vacuum Circuit Breaker shall be used to control and isolate the 11kV/433V Distribution transformer. The transformer Low Voltage side shall be connected to Low Voltage switchgear. The connection cables to consumer shall be taken out from the Low Voltage switchgear.

The prefabricated-package substation shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

S. No.	DPS Name	Required Capacity of each Transformer (KVA)	Required HT Side-VCB	Required LT Side-ACB
1	Big Hospital	500 X 1 no	11 KV-630A X 1 no	415 V -1000A X 1 no
2	Khagul - Danapur Near Hitech Hospital	630 X 1 no	11 KV-630A X 1 no	415 V -1500A X 1 no
3	Bakri Bazar	630 X 1 no	11 KV-630A X 1 no	415 V -1500A X 1 no
4	Karori chak	630 X 1 no	11 KV-630A X 1 no	415 V -1500A X 1 no
5	Dasaradha	1000 X 1 no	11 KV-630A X 1 no	415 V -2000A X 1 no
6	Digha (Near Old Thana)	1000 X 1 no	11 KV-630A X 1 no	415 V -2000A X 1 no
7	Nandal Chapra	1000 X 1 no	11 KV-630A X 1 no	415 V -2000A X 1 no
8	Premkunj (Kamali Chowk)	1000 X 1 no	11 KV-630A X 1 no	415 V -2000A X 1 no
9	Rajiv Nagar	1000 X 1 no	11 KV-630A X 1 no	415 V -2000A X 1 no
10	Buer Bethode Pul	1250 X 1 no	11 KV-630A X 1 no	415 V -2500A X 1 no
11	Isopur Brama Ashta	1250 X 1 no	11 KV-630A X 1 no	415 V -2500A X 1 no
12	Gurudaur Nehru Path	1600 X 1 no	11 KV-630A X 1 no	415 V -3000A X 1 no
13	Kanpur	2000 X2 nos	11 KV-630A X 2 no	415 V -3500A X 2 no
14	Bermutta	2000 X2 nos	11 KV-630A X 2 no	415 V -3500AX 2 no

2.1.44. SERVICE CONDITIONS:

The Package substation shall be suitable for continuous operation under the basic service conditions indicated below

Ambient Temperature: 50 Deg C
Relative Humidity upto 95%
Altitude of Installation upto 1000m

The Enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package substation shall be designed to be used under **normal outdoor service condition** as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

2.1.45. SPECIFIC REQUIREMENT

The main components of a prefabricated- package substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible, bus bars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IEC standards.

Ratings:

Description	**Unit**	**Value**
Rated Voltage / Operating Voltage	kV rms	11
Rated frequency & Number of phases	Hz & nos.	50 & 3
Rated maximum power of substation	kVA	As per Requirement
Rated Ingress protection class of Enclosure	IP:	IP-23 for Transformer Compartment and IP:54 for LT & HT Switchgear Compartment.
Rated temp Class of Transformer Compartment		K10 upto 1250kVA
HV Insulation Level		
Rated withstand voltage at power frequency of 50 Hz	kV rms	28
Rated Impulse withstand Voltage	kV peak	75
HV Network & Busbar		
Rated current	Amp	630A
Rated short time withstand current	kA rms / 3 sec	21
Making capacity for switch-disconnector & earthing switches	kA peak	50kA
Breaking capacity of Isolators (rated full load)	A	630A
LV Network		As per requirement.

2.1.46. OUTDOOR ENCLOSURE

Outdoor enclosure:

The outdoor enclosure shall be made of galvanized Sheet Steel tropicalized to local weather conditions.

The enclosure shall be of partially modular design of GI sheets fastened by riveting.

The thickness of enclosure shall be 1.5 mm for non-load bearing members & 2mm for load bearing members.

The enclosure shall be painted with Powder Coating/polyurethane paint.

The metal base shall ensure rigidity for easy transport & installation.

Substation will be used in outdoor application hence to prevent enclosure from rusting/corrosion, welding should be avoided.

The protection degree of the Enclosure shall be IP54 for LT & HT switchgear compartment & IP23 for Transformer compartment. Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.

Considering the outdoor application of the substation the doors shall be provided with proper interlocking arrangement for safety of operator and to avoid corrosion door should have stainless steel hinges. Door should be provided with stoppers.

Interconnection between HT switchgear and transformer shall be using 1Cx3x95 sq.mm al. unarmored XLPE cable and between transformer and LT switchgear shall be using busbar.

Internal Fault: Failure within the package substation due either to a defect, an exceptional service condition or mal operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided. The Design shall be tested as per IEC62271-202. **Type test report of arcing due to internal fault should submitted with offer. The Compact substation shall be tested for internal arc test –AB for 21KA for 1 sec (A-operator, B-pedestrian)**

Covers & Doors: Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90^0 & be equipped with a device able to maintain them in an open position. **The doors shall be lockable type with cylindrical shooting bolt and the locking arrangement shall be covered by magnetic flap.**

The roof of the transformer compartment shall be detachable type to access the transformer for maintenance purpose

Earthing: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

a) The enclosure of Package substation,
b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
c) The metal screen & the high voltage cable earth conductor,

d) The transformer tank or metal frame of transformer,
e) The frame &/or enclosure of low voltage switchgear,

There shall be an arrangement for internal lighting activated by associated switch for HV , Transformer & LV compartments separately.

Labels: Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.

Cleaning & Painting:
The paints shall be carefully selected to withstand tropical heat and rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. **The enclosure shall be painted with powder Coating.**

11KV SF6 METAL ENCLOSED, INDOOR RING MAIN UNIT (RMU).

This RMU should be complete with all components necessary for its effective and trouble-free operation along with associated equipment etc. such components should be deemed to be within the scope of supplier's supply.
The RMU should be fixed type SF_6 insulated with Vacuum circuit breakers with O/C & E/F relay for the protection of the transformer. It should be maintenance free equipment, having stainless steel robotically welded IP67 enclosure.

2.1.47. STANDARDS AND REFERENCE DOCUMENTS

Codes and Standards

The **RING MAIN UNIT (RMU)** should be designed, manufactured and tested to the latest version of:

IEC 60694 Common specifications for high-voltage switchgear and control gear standards.
IEC 62271-200: A.C metal-enclosed switchgear and control gear for rated voltages above 1KV and up to and including 72KV and the IEC Codes herein referred.
IEC 60129/ IEC 62271-102: Alternating current disconnections (isolators) and earthing switches
IEC 60529: Classification of degrees of protection provided by enclosures
IEC 60265 High-voltage switches-Part 1: Switches for rated voltages above 1kV and less than 52 kV
IEC 60056: Circuit breakers
IEC 60420 High-voltage alternating current switch-fuse combinations
IEC 60185 Current transformers
IEC 60186 Voltage transformers
IEC 60255 Electrical relays
Any other codes recognized in the country of origin of equipment might be considered provided that they fully comply with **IEC standard**s.

The design of the switchgear should be based on safety to personnel and equipment during operation and maintenance, reliability of service, ease of

maintenance, mechanical protection of equipment, interchangeability of equipment and ready addition of future loads.

2.1.48. SALIENT TECHNICAL FEATURE OF "SF6 RMU."

11KV SF6 INDOOR, NON-EXTENSIBLE, Ring Main Unit (RMU), comprising of 1No. 630 A Vacuum Circuit Breaker & 1 No Air Insulated Metering Module with (3 O/C & 1E/F) Relays.

(A) Circuit Breaker. (630A)
Circuit Breaker should have the following:
- Manually operated 630 A Vacuum circuit breaker and Earthing Switch with making capacity
- Mechanical tripped on fault indicator
- Auxiliary contacts 1NO and 1NC
- Anti-reflex operating handle
- "Live Cable" LED Indicators thru Capacitor Voltage Dividers mounted on the bushings.
- 3O/C + 1E/F self powered relay with Low and High set for Over current and Earth Fault. Relay should have facility to display the maximum loaded phase current also. Relay should have facility to trip the breaker from remote commands without shunt trip coil.
- Mechanical ON/OFF/EARTH Indication

2.1.49. INDOOR RMU

1. Modular design, panel type with front cable access.
2. RMU must be made of robotically welded Non Ferrite, Non magnetic stainless steel with thickness of 2.5 mm with all live parts inside stainless steel tank
3. Offered RMU must be Non extensible.
4. Maximum Modules can be accommodated in a single robotically welded Stainless steel Tank so as to make it more compact and reliable.
5. Cable covers must be interlocked with Earth switch to have complete safety of operating person. The cable bushings shall be bolted type design.

DIELECTRIC MEDIUM

SF6 GAS shall be used for the dielectric medium, **Arc quenching should take place in vacuum** for 11KV RMU's in accordance with IEC376. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption. The SF6 insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a simple go, no-go indication.
The RMU should have provision of Gas filling at site , in case there is some leakage of the gas.

2.1.50. GENERAL TECHNICAL REQUIREMENTS

Fixed type Vacuum breakers insulated in SF6 gas. It should be maintenance free, having stainless steel robotically welded enclosure for INDOOR RMU application.

Low gas pressure devices- 1.4 Bar pressure. RMU should have full rating with Bar gas pressure.

i. Live cable indicators- High operator safety.
ii. Fully Rated integral earthing switch for Switches and Breakers.
iii. Self powered Microprocessor Based 3O/C + 1E/F self powered relay with Low and High set for Over current and Earth Fault - Does not require any external source of power.
iv. Units fully SCADA Compatible. Retrofitting at site possible at a later date. Line switches (Load break switches) as well as T- OFF circuit Breaker can be operated by remote.
v. Cable boxes should be front access and interlocked with earth switch. No rear access required.
vi. Cable testing possible without disconnection of cables.
vii. Compact in dimension.
viii. Low pressure, sealed for life equipment,
ix. Cable earthing switch on all switching device-standard, for operator safety.
x. All live parts should be inside a hermetically sealed Stainless Steel enclosure for indoor RMU.
xi. Indoor unit should be classified as sealed pressure system with gas leak rate of less that 0.1% per year requiring no gas filling for 30+ years of functional life.

2.1.51. TECHNICAL AND GUARANTEED PARTICULARS.

The bidders shall furnish all guaranteed technical particulars as called for this specification.

DESIGN CRITERIA

Service conditions

The offered switchgear and control gear should be suitable for continuous operation under the basic service conditions indicated below. Installation should be in normal indoor conditions in accordance with IEC 60694.
Ambient temperature -1oC to +45oC
Relative humidity up to 95%
Altitude of installation up to 1000m, IEC 60120

General structural and mechanical construction

The offered RMU should be of the fully arc proof metal enclosed, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units. Each unit is made of a cubicle sealed-for life with SF6 and contains all high voltage components sealed off from the environment. The overall design of the switchgear should be such that front access only is required. It should be possible to erect the switchboard against a substation wall, with HV and LV cables being terminated and accessible from the front.

The units should be constructed from robotically welded NON Ferrite

,Non Magnetic grade stainless steel sheets of 2.5mm thickness to

ensure very high degree of precision in sealing of SF6 tank. The design

of the units should be such that no permanent or harmful distortion occurs

either when being lifted by eyebolts or when moved into position by

rollers.

The cubicle should be have a pressure relief device. In the rare case of an internal arc, the high pressure caused by the arc will release it, and the hot gases is allowed to be exhausted out at the bottom of the cubicle. A controlled direction of flow of the hot gas should be achieved.
The switchgear should have the minimum degree of protection (in accordance with IEC 60529)
- IP 67 for the tank with high voltage components
- IP 2X for the front covers of the mechanism
- IP 3X for the cable connection covers

The RMU shall be internally arc tested for 20kA for 1 sec for the gas tank & it should be internally arc tested for cable compartment. Relevant type test reports should be submitted by the manufacturer.

TECHNICAL DATA

Ring Main Unit, Electrical data

Electrical data and service conditions

No	***Rated voltage***	KV	***12KV***
1	Power frequency withstand voltage	KV	28
2	Impuls withstand voltage	KV	95
3	Rated frequency	Hz	50
4	Rated current busbars	A	630
5	Rated current (cable switch)	A	630
6	Rated current (T-off)	A	630

Breaking capacities:

7	active load	A	630
8	closed loop (cable switch)	A	630
9	off load cable charging (cable switch)	A	135
10	earth fault (cable swich)	A	200
11	earth fault cable charging (cable switch)	A	115
12	short circuit breaking current (T-off circuit breaker)	kA	21
13	Rated making capacity	kA	52.5
14	Rated short time current 3 sec.	kA	21

Ambient temperature:

15	Maximum value	°C	+ 45
16	Maximum value of 24 hour mean	°C	+ 35
17	Minimum value	°C	0
18	Altitude for erection above sea level	4m	...1000
19	Relative humidity		Max 95%

Ring Main Unit Technical data(11KV) INDOOR

General data, enclosure and dimensions

1 Standard to which Switchgear complies IEC

2 Type of Ring Main Unit Metal Enclosed, Panel type, Compact Module.
3 Number of phases 3
4 Whether RMU is type tested Yes
5 Whether facility is provided with pressure relief Yes
6 Insulating gas SF6
7 Nominal operating gas pressure 1.4 bar abs. 20° C
8 Gas leakage rate / annum % 0.1% per annum
9 Expected operating lifetime 30 years
10 Whether facilities provided for gas Yes, temperature compensated manometer
monitoring can be delivered
11 Material used in tank construction Stainless steel sheet

No Operations, degree of protection and colours

1 Means of switch operation separate handle
2 Means circuit breaker operation separate handle and push buttons
3 Rated operating sequence of Circuit Breaker O –3min-CO-3min-CO
4 Total opening time of Circuit Breaker approx. . 40-80ms
5 Closing time of Circuit Breaker approx. . 40-70ms
6 Mechanical operations of switch CO 1000
7 Mechanical operations of CO earthing switch 1000
8 Mechanical operations of circuit breaker CO 2000
9 Principle switch / earth switch 3position combined switch

Degree of protection:

10 High Voltage live parts, SF6 tank IP 67
11 Front cover mechanism IP 2X for Indoor
12 Cable covers IP 3X for Indoor

Colours:

14 Front cover 7035
15 cable cover 7035

PANEL CB DESCRIPTION

CIRCUIT BREAKERS

Vacuum bottles should be use as interrupters of the currents. The circuit breaker main circuit should be connected in series with a three-position disconnector –ear thing switch. The operation between circuit breaker and disconnector ear thing must be interlocked.

1.VCB must self tripping and has a self powered relay
2.The RMU must be nonextensible type

OTHER MAIN FEATURES

Bus bars:

Comprising the 3 single phases copper bus bars and the connections to the switch or circuit breaker. The bus bar should be integrated in the cubicle Bus bars should be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.

Earthing Switch

Earthing switches should be rated equal to the switchgear rating.

Earthing switches should be quick make type capable of making Rated Fault Current. Ear thing switch should be operated from the front of the cubicle by means of a removable handle.

The mechanisms

All mechanisms should be situated in the mechanism compartment behind the front covers outside the SF6-tank. The mechanism for the switch and the earthing

switch is operating both switches via one common shaft. The mechanism provide independent manual operation for closing and opening of the switch, independent closing of the
earthing switch and dependent opening of the earthing switch.
The mechanism for the T-off switch and earthing switch is operating both switches via one common shaft. The mechanism has stored spring energy and provide independent manual operation for closing and opening of the switch, independent closing of the ear thing switch and dependent opening of the ear thing switch. The mechanism for the vacuum circuit breaker (VCB) and disconnector- earthing switch is operating the VCB and the disconnector earthing switch via to separate shafts. The mechanism for the VCB has stored spring energy and provides independent manual operation for closing and opening of the VCB. The mechanism has a relay with related CT's and/or remote tripping device. The mechanism for the disconnector earthing switch provide independent manual operation for closing and opening of the disconnector, independent closing of the earthing switch and dependent opening of the earthing switch.

Front covers

The front cover contains the mimic diagram of the main circuit with the position indicators for the switching devices. The voltage indicators are situated on the front panels. Access to the cable bushings is in the lower part of each module.

Position indicators

The position indicators are visible through the front cover and are directly linked to the operating shaft of the switching devices.

Voltage indicator

The voltage indicators are situated on the front cover, one for each module, and indicate the voltage condition of each incoming cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator satisfies the requirements of IEC61243.

Cable compartment

The Cables access in the RMU shall be from the front. **The cable bushings shall be easily site-replaceable type.**

It should be possible to terminate up to a 1x 3c x300sqmm core HV cables in each cable compartment. The access to the compartment will be possible by removing the cable cover, Hinged to the main frame only when earth switch is ON. Cable Compartments of Indoor RMU should be Arc Proof tested for 20kA for 1sec (the type test report for the same shall be submitted by the vender) and interlocked with respective Earth Switches.. Each module has a separate cable compartment that is segregated from each other by means of a partition wall. A partition wall should be fitted to divide the cable compartment from the rear side of the switchgear. In case of an arc inside the tank, followed by the opening of the pressure relief, the partition wall prevents the hot gases flowing out from the pressure relief to enter the cable compartments. All covers are removable.
Interconnection between HT switchgear and transformer shall be using 1Cx3x95 sq.mm Al. unarmoured XLPE Cable.

Power connection.

The cables are installed in the dedicated compartment below the mimic front cover. At the bottom of the cable compartment, an earthing bar system made of copper/GI with a minimum cross section of 120 mm^2 should be fitted. In each compartment the earthing bar should be fitted with 4 screws M10. The earthing system is connected to the tank by a copper/GI bar, which rises up to the connecting point of the tank behind the rear partition wall on the middle of the switchgear.

INTERLOCKING.

The mechanism for the cable switch should be provide a built in interlocking system to prevent operation of the switch when the earthing switch is closed, and to prevent operation of the earthing switch when the switch is in the closed position.

The mechanism for the T-off switch should be provide a built in interlocking system to prevent operation of the switch when the earthing switch is closed, and to prevent operation of the earthing switch when the switch is in the closed position. The mechanism for the VCB and the disconnector-earthing switch should be has a built in interlocking system to prevent operation of the disconnector-earthing switch when the VCB is in the closed position.

Further is should not be possible to Open the Cable doors unless the Earthing Switch is Turned ON. In case the Cable door is accidentally left open a positive interlock shall prevent operation of Load Break Switch and Isolators / Breaker from any operation.

Current Transformers

All current transformers should be complying with IEC 60185.

Current transformers should be of dry type, with ratings and ratios as required. Cable current transformers used in circuit breaker modules should be maximum 100mm wide. Current transformers used in metering cubicles should be having dimensions according to DIN 42600, Narrow type. Current transformer shall be placed in the cable covers so that it can be easily replaced at site without removing the bushings.

Auxiliaries.

The switchgear should be prepared for options like motor operation, auxiliary contacts and short-circuit indicators. Necessary terminal blocks and wiring etc. should be placed behind the front cover of each module.

Fault Passage Indicators.

These shall facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The unit should be self-contained requiring no auxiliary power supply. The FPI shall be integral part of RMU to avoid thefts. The FPI shall have clear display, automatic reset facility and shall be SCADA compatible.

TESTING AND CERTIFICATION.

TYPE TESTS.

Units should be type tested in accordance with IEC standards 60056, 60129, 60265,

60298,60420,60529 and 60694. The following type tests should perform on the HT Switchgear and report should submit with offer.

- Short time and peak withstand current test
- Temperature rise tests
- Dielectric tests
- Test of apparatus i.e. circuit breaker and earthing switch
- Arc fault test
- Measurement of resistance of main circuit.
- Mechanical endurance test.
- Duty cycle test.
- Internal arc test for HT chamber.

- Type test reports for above type shall be submitted with the offer.

ROUTINE TESTS.

Routine tests should be carried out in accordance with IEC 60298 standards. These tests should be ensure the reliability of the unit.

Below listed test should be performed as routine tests before the delivery of units;

- Withstand voltage at power frequency
- Measurement of the resistance of the main circuit
- Withstand voltage on the auxiliary circuits
- Operation of functional locks, interlocks, signalling devices and auxiliary devices
- Suitability and correct operation of protections, control instruments and electrical connections of the circuit breaker operating mechanism
- Verification of wiring
- Visual inspection
- Time travel characteristics measurement facility for Breaker should be available with the manufacturer to asses the quality of RMU.

Distribution Transformer

Oil filled Transformer :

Requirement: 11000/433 Volt Oil immersed hermetically sealed, corrugated tank and without conservator type design ONAN cooled suitable for installation at outdoor in Enclosure for ground mounting.

Voltage Ratio: No load voltage 11000/433 volts within tolerance as stipulated in IEC 76.

Rating: The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

Temperature Rise: The maximum temperature rise at the specified maximum continuous output shall not exceed 40°C by thermometer in the hottest portion of the oil or 45°C measured by resistance of winding above ambient temperature, not exceeding 50°C maximum.

Connections: H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group DYn11.

Tapping : Each transformer shall be provided with **sliding/rotary type tap switch** so as to provided for a voltage adjustment on H.V. from +5% to –10% of rated voltage of 11000 volts in 4 equal steps (5 position) to obtain rated voltage of 433 volts on LV side. Refer clause no:4.5.4 for details of rotary switch. The tapping shall be provided for following voltage ratios at no load.

Cleaning & Painting :

a) All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents, as required to produce a smooth surface free of scales, grease and rust.
b) The internal surfaces in contact with insulating oil shall be painted with heat resistant insulation paint which shall not react & be soluble in the insulating liquid used.
c) The external Surfaces, after cleaning, shall be given two coats of high quality epoxy based rust resisting primer followed by filler coats.
d) The transformer shall be furnished with coats of weather resisting battleship gray epoxy based enamel paint specially recommended for transformer use.
e) The paints shall be carefully selected to withstand tropical heat rain, effect of proximity to the sea etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
f) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

Both H.V. and L.V. bushings shall have creepage corresponding to **very heavily polluted atmosphere**.

Oil: New transformer oil used shall be according to relevant IEC standards

Phase Marking & Danger Plate: Phase markings in fluorescent paint on small non-corrodible metallic tags shall be permanently fixed for H.V. and L.V sides. Phase markings tags shall be properly fixed with proper alignment. Danger plates shall be provided on the H.V & LV sides, mentioning the Corresponding Voltages.

Core and Coil :

Core : The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.

The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding.

Noise: The Contractor shall take special precautions to ensure that the noise and vibration level does not exceed which is obtained in good modern practice.

Impedance Volts: The Percentage impedance value at 75 Deg. C at any tap shall be as per IS/ IEC subject to tolerance as specified in relevant IEC standards. i.e. 4.5% upto 630kVA and 5% upto 1250kVA The value of the impedance volts at each tapping over the specified range shall be specified in the bid.

Regulation: The regulation at 75° C at full load at unity and 0.8 power factor subject to the usual tolerance as per IEC standards shall be specified in the bid.

Power Freq. High Voltage & Insulation Level (Impulse voltage): The distribution transformer shall be designed so that they are capable of withstanding high voltage & impulse voltages as given below:

a) Impulse Voltage for 11kV winding: 75 kV (1.2/50 Microsecond wave shape).
b) High Voltage : 28kV rms.

10.4.0 RATINGS (Summary) :

	Application	**Dist. Tfr. with Corrugated Tank**
4.4.1	Service	Outdoor application inside enclosure Step down
4.4.2	Type	Oil immersed corrugated tank
4.4.3	Cooling system	ONAN
4.4.4	No. of Phases	3
4.4.5	No. of winding per phase	2
4.4.6	Rated output (MVA) With ONAN cooling	HV / LV
4.4.7	Rated voltage in KV (Line to Line	HV-11 kV LV-0.433 kV
4.4.8	Rated frequency	50 Hz
4.4.9	Temperature rise above 50°C	
A	In winding by resistance	45°C
B	In Oil by thermometer	40°C
4.4.10	Guaranteed losses at 75°C and at normal tap position as pe IS tol.	
	Losses as per IS1180 level 2	**As per IS1180 level 2**
A	50% Loading (W)	
B	100% Loading (W)	
4.4.11	Insulation level	
A	H.V. Power Freq. KV rms	28 kV
B	H.V. (kVpeak) Impulse	75 kV
C	L.V. (kV)	-
4.4.12	Vector Group	Dyn11
4.4.13	Type of taps provided	Off Load full capacity
A	Taps provided on	H.V. winding
B	Range of taps	+5% to – 5% in steps of 2.5% (6 steps, 5 position)
C	Method of Tap Change control	Rotary /sliding Switch
D	Manual load	Yes ‘Off Circuit’
4.4.14	Percentage impedance at 75 Deg. C	As per IS.
4.4.15	System earthing	
A	H.V.	Solidly earthed
B	L.V.	Solidly earthed
4.4.16	Terminal arrangement	
A	H.V.	From H.V. Bushing on Top.
B	L.V.	From L.V. Bushing on Top.

C	L.V. Neutral	From L.V. Neutral Bushing on Top.
4.4.17	Transformer-bushing voltage class a) H.V. (kV) b) L.V. (kV)	 12 kV class 1.1kV class
4.4.18	System fault level a) H.V. side b) L.V. side	 500 MVA (11 kV) -
4.4.19	Short circuit withstand capability duration	3 sec.

Fittings & Accessories For Corrugated Tank Transformer :
The following accessories shall be provided for 11 kV/0.433 kV, distribution transformer.

Two earthing terminals with copper lugs. The lugs shall be provided in such a way that they shall not obstruct the movements of rollers. The earthing continuity for all the connected equipments shall be properly done.

Two lifting lugs for complete transformer as well as enclosure.

Off circuit tapping switch shall be rotary/sliding type, 3 pole gang operated, top mounting draw out type only. Tap switch shall be suitable for operating voltage of 11kV and above and shall have rated current of 16.53A/26.54A/39.64Amps. Switch shall be provided with externally operating hand wheel handle with indicator and locking device, with direction changing facility and locking arrangement. Bidders shall submit with the bid, technical catalogue for the off load tap switch for Purchaser's approval.

Rating plate and diagram plate of durable non-corroding metal giving information as required under IEC 76. Rating plate shall also include Transformer **Actual %Z, No-Load Loss & Full-Load Loss at 75°C** along with details like Purchase Order Number, date. The name plate marking shall be done with fluorescent colour. Each equipment shall carry individual name-plate with proper instructions & affixed with screws.

Four plain rollers fitting so that the transformer can suitably moved in any direction along
with roller direction changing and locking facility shall be provided.
Skid with Haulage lugs.

Instructions & affixed with screws.

Skid with Haulage lugs.

L.T. PANEL

System:-

a) **Declared voltage** :– 3 Phase,400V (±6%) 50 Hz,
b) **Neutral** :– Solidly earthed at substation.
c) **Busbar** – Aluminum

General finish:- Tropical, totally enclosed, metal-clad, weather-proof, vermin and dust
proof.

Construction :

Enclosure:- Dead Front type of enclosure shall be able to provide the degree of Protection IP:2X.

Circuit Ways: As per BOQ

- Air Circuit breaker will be of 3P/4P, 36kA fixed manual microprocessor based over current, short circuit and earth fault release.
- Molded case circuit breaker will be of 3P/4P,35kA fixed manual microprocessor based
- Overload and short circuit release.
- The design of the LT panel should be type tested for the short circuit , temperature & Ingress protection test and type test report should submit with offer**.**

GENERAL CHARACTERISTICS OF ACB

Conformity with Standards

The air circuit-breakers used in low voltage installations are constructed and tested in accordance with the IEC 947/IS 947 Standards and respect the following EC directives:

– "Low voltage Directive" (LVD) No. 73/23 EEC

– "Electromagnetic compatibility Directive" (EMC) No.89/336 EEC

Functional characteristics

– The circuit-breakers must have a rated service voltage of 690 V AC and a rated insulation voltage of 1000 V.

– The circuit-breakers must have a rated impulse withstand voltage of 12 kV.

– The rated uninterrupted current must be between 800 and 6300 A with the possibility of selection of ratings from 400 A.

– Different versions shall be available with rated ultimate short circuit breaking capacity(Icu) from 50kA at 415V and shall have rated short circuit service breaking capacity(Ics) equals to Icu.

– Different versions of circuit-breakers shall be available with rated short-time withstand current (Icw -1 sec) for 50kA for 1sec in category B.

– It must be possible to supply the circuit-breakers both from the top and bottom terminals without derating their performances and without jeopardising their functionality.

– The mechanical life must be at least 12000 operations, without the need for maintenance of the contacts and arcing chambers.

– The electrical life at a voltage of 440 V AC must be and without the need for maintenance of the contacts and arcing chambers:

– at least 9000 operations up to 2000 A

– at least 6000 operations up to 3200 A

these values are intended to bevalid only for CAT B circuit-breakers.

Environmental characteristics

– Operating temperature: -25 °C...+70 °C (-13 °F...158 °F)
– Storage temperature: -40 °C...+70 °C (-40 °F...158 °F)
– Altitude: operation without derating up to 2000 m a.s.l. (6600 ft), and with derating up to 5000 m a.s.l. (16500 ft)
– Suitability for use in a hot-humid environment. With regard to this, the circuit-breakers must undergo a tropicalisation process which makes them suitable for use in a hot-humid environment, as established by the prescriptions of the main shipping registers and in accordance with the international IEC 60068-2-30 Standards.

Construction characteristics

– The circuit-breaker structure must be made of steel sheet.
– There must be total segregation between power and front shield, using double insulation where suitable so as to guarantee maximum operator safety.
– Total segregation between the phases must be guaranteed for safety reasons.
– The main contacts must be separate from the arcing contacts in cat. B circuit-breakers only.
– It must be possible to inspect easily the arcing chambers easily and to check main contact wear with the circuit-breaker racked-out, by removing the arcing chambers.
– All the circuit-breakers in the range have the same height and depth with the aim of standardising the supporting structures of the switchgear and the switchgear itself as far as possible.
– The circuit-breakers must indicate the precise position of the main contacts and the condition of springs charged/discharged on the front, by means of certain and reliable signals.
– The operating mechanism must be of the stored energy type with operation by means of precharged springs fitted with antipumping device. The springs are charged manually by activating the front lever, or by means of a geared motor, supplied on request.
– The whole range of air circuit-breakers must be fitted with electronic protection releases. It must be allowed the interchangeability of protection releases from skilled personnel.
- ACBs shall have minimum watt losses in order to restrict temperature rise inside the breaker.

RELEASES

1) Release (Protection functions)

– The release must not require auxiliary power supplies since the power is taken from the current transformers.
– The signals supplied by the release must not operate with power supply supplied by internal batteries.The basic version of the release must provide:
– protection against overload with trip with inverse long time delay (L)
– protection against instantaneous short-circuit (I)
– Selective short-circuit (S)
– Earth fault (G)

The setting ranges shall be:

– Protection against overload (L)
  Characteristic t=k/I2
  Trip threshold I1=(0.4...1)xIn with timing adjustable from 3 to 144 sec. (value referred to a current equal to 3xI1)
– Protection against selective short-circuit (S)
  Characteristics t=k and t=k/I2
  Trip threshold I2=(1...10) xIn with timing adjustable from 0.1 to 0.8 sec.
  (value referred to a current equal to 10xIn for curves at t=k/I2 and referred to currents >I2 for curves at t=K)
– Protection against instantaneous short-circuit (I)
  Trip threshold I3=(1,5...15) xIn
– Protection against earth fault (G)
  Characteristics t=k and t=k/I2
  Trip threshold I4=(0.2...1) xIn with timing adjustable from 0.1 to 0.8 sec. (value referred to a current equal to 4xI4)
– Neutral protection level:
  50% - 100% - 200% - excluded

All the protection functions except protection against overload must be excludable

User interface and signalling LEDs

– The release shall allow parameterisation of the trip thresholds and timing by means of dipswitches.
– alarm and trip signalling for all the protection functions by means of LEDs located on the release shall be available. No batteries or external power supplies shall be necessary for powering these indicators. The indication shall be available for not less than 48 hours after the trip, even with the circuit-breaker open
– An alarm shall indicate by means of LEDs located on the release the disconnection of opening solenoid and current transformers. A trip shall also occur, after a short time delay, when the disconnection is detected.
– It shall be possible, with the aid of external devices, to read currents, and information on last 10 trips (currents, protection tripped) occoured to the unit.

General aspects of MCCB with microprocessor based release

Standards conformity

Molded case circuit-breakers (MCCB) installed in the low voltage plant must be designed,
manufactured and tested according with the international standards IEC 60947-1, IEC 60947-2,
IEC 60947-3, IEC 60947-4-1, IEC 61000 or with the corresponding harmonized national standards, the CE “Low Voltage Directives” (LVD) n° 73/23 EEC and “Electromagnetic
Compatibility Directive” (EMC) n° 89/336 EEC.

Molded case circuit breakers functional features

– Rated insulation voltage (Ui) for MCCB shall be 800 VAC or more.

- Rated Impulse withstand voltage (Uimp) for mccb's shall be 8kV.

- Rated service voltage(Ue) for the moulded case circuit breaker shall be standard as 690V, however performance on short circuit level shall be consider based on system operating voltage.

- Rated uninterrupted current between varying from 160 and 3200 A with trip units settings starting from 10A

- Rated short circuit breaking capacity shall be considered as per bill of material and the rated service short circuit breaking capacity (Ics) shall be in 100% of rated ultimate short circuit breaking capacity (Icu). (Ics=Icu)

- According to IEC 60947-2 (§ 4.4) starting from 400 A the circuit breakers must be category B, however other small rating category A shall be confirmed.

- MCCBs must be available with different ultimate short breaking capacities between 16kA and 200kA @ 380/415 V AC.

- Both line up and line down supplying must be possible without decreasing MCCBs performances or functionality

- MCCB shall confirms to current limiting type and this feature shall ensure less amount of let through energy at the time of opening on fault. The mccb shall have opening time less then 10msec for current rating upto 630A, and less them 15msec for current rating upto 1600Amps.

- A test bottom for the correct functionality checking (moving contacts opening) must be place in front of the breaker.

Ambient characteristics

- Operating temperature: -25 °C .. +70 °C (ambient temperature)
- Storage temperature: -40 °C .. +70 °C (ambient temperature)
- Maximum relative humidity: 98%
- Maximum altitude: 2000 m above sea level, 5000 m above sea level with derating
- Suitability for being used in hot-humid places.
- Circuit-breakers fitted with electronic trip units must comply with the prescriptions of the International Standards on electromagnetic compatibility.

Construction characteristics

- The range of moulded case circuit-breakers must cover a range of rated uninterrupted currents from 160 to 3200 A.

- By means of the double insulation technique, moulded case circuit-breakers must guarantee complete separation between the power circuits and the auxiliary circuits.

- Moulded case circuit-breakers must have an operating lever which always indicates the exact position of the circuit-breaker contacts (positive operation), by means of safe and reliable signals (I= closed, O= open, yellow-green line= open due to trip unit).

- Moulded case circuit-breakers must be suitable for isolation in compliance with § 7.2.7 of the IEC 60947-2 Standard. This indication must be clearly and indelibly marked on the circuit-breaker (in accordance with § 5.2 of IEC 60947-2) and in a position where it is visible with the circuit-breaker installed.

- Moulded case circuit-breakers with rated uninterrupted current up to 250 A shall have a 45 mm high face which makes them suitable for installation on modular panels.

- The same depth must be guaranteed from 320 A up to 1000 A, in order to standardize both switchboards and their supports.

- All the installation positions must be possible without jeopardizing the function of the apparatus. Starting from 630 A up to 1600 A the withdrawable version shall be mounted and operated horizontally.

- For the front parts of the circuit-breakers the degree of protection of at least IP20 (excluding the terminals) must be guaranteed.

Protection trip units

- From the 250 A size circuit-breakers, the trip unit must be interchangeable.

Electronic overcurrent releases

- The electronic overcurrent trip units must be self-supplied and must be able to guarantee correct operation of the protection functions even in the presence of a single phase supplied with a current value equal to 20% of the phase current.

- They must be unaffected by electromagnetic interference in compliance with the EMC directive on the matter.

- The basic version shall be fitted with protection functions against overload (function L) and against short-circuit. The latter function can either be of the instantaneous type (function I) or, alternatively, with intentional delay (function S). The function of protection against short circuit must be excludable. A basic version shall also be provided with only the protection threshold against instantaneous short-circuit which cannot be excluded.

- The minimum performances of the protection functions of the electronic protection trip unit for distribution, where present, must be:

    1. Function **L**:adjustable trip threshold I1= (0.4...1) x In, trip curves for the basic version with times from 3 to 12 seconds – 2 different trip curves - (at 6 times the set threshold). Cannot be excluded.

    2. Function **S**: adjustable trip threshold I2= (1...10) x In, trip curves for the basic version with times from 0.1 to 0.25 seconds – 2 different trip curves – (at 8 times the rated current of the trip unit.Can be excluded.

    3. Function **I**: adjustable trip threshold I3= (1...10) x In for the basic version (instantaneous trip). Can be excluded.

- All the protection functions must be characterized by threshold and time tolerances according to the International Standards.

- The size of the current sensors must be a minimum of 10 A to a maximum of 3200 A so as to cover the widest possible current range.

Earthing:

Earthing arrangement shall be provided for earthing each cable, PVC cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked .The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.

Neutral bus bar strip shall be connected to Earthing terminal with help of GI strip of suitable capacity & nut-bolt arrangement.
Earthing Strip of Size 50x6mm GI is require for CSS internal Earthing.

2.1.52. TYPE / ROUTINE TEST ON PACKAGE SUBSTATION

TYPE TESTS FOR THE PACKAGE SUBSTATION:

The Package Substations offered must be type tested as per IEC 62271-202. The copy of type test summary should be submitted along with the tender. CSS manufactured at in JV consortium/system integrator/OEM shall not be accepted.

Routine Tests: The routine tests shall be made on each complete prefabricated substation.

a) Voltage tests on auxiliary circuit.
b) Functional test.
c) Verification of complete wiring.

Test Witness: Routine test shall be performed in presence of Owner's representative if
so desired by the Owner. The Contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

Test Certificates:

Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of the Owner.

Performance Certificate to Qualify Technical Bid: Manufacturer should submit CSS performance Certificate from Any Utility/Pvt organization/Industry of similar or higher rating.

Packaged Substation Enclosure:

- Tests to verify the degree of protection.

- Arcing due to internal fault
- Test to prove enclosure class - Temperature rise of the transformer inside the enclosure.
- Short circuit test to prove the capability of the earthing circuits to be subjected to the rated peak and the rated short time withstand currents.
- Tests to verify the withstand of the enclosure of the prefabricated substation against mechanical stress.

VFD PANEL

2.1.53. SCOPE OF SUPPLY

Scope of supply shall cover design, engineering, manufacture, test at manufacturer's works,
packing and transportation to site of the panel in accordance with the stipulations mentioned
hereunder.

2.1.54. CODES STANDARDS

The panel shall generally comply with the relevant International Standards (IEC) Specifications and
relevant codes and practices.

Panel wiring Insulation: IEC 60664.
MPCB/HRC cartridge fuses: IEC 60947-3.
Control switches, Contactors: IEC 60947-4-1.
Circuit Breakers & Relays: IEC 60898.
Degree of protection: IEC 60529.
Electrical safety & Human protection IEC 61140.

2.1.55. GENERAL CONSTRUCTIONAL FEATURES

The panel shall be completely metal clad enclosed, free standing, non draw out, sheet steel Cubicle,indoor free floor mounting, non compartmentalized, **single front,** individual vertical **c**ompartmental type and shall be dust tight, moisture, vermin proof, highly corrosive-resistive. Under normal operation and maintenance, the modules and cable connections shall be accessible from both sides of the feeders. The panel shall be maximum height of 2100mm from floor level and depth of 500mm maximum. All feeders of panel shall be suitable for bottom cable entry only. Copper bus bars for PCC panls and Aluminum bus bars for MCC panels shall be used with adequate sizes.

The panel shall be free from undulations, dents and flaws and sufficiently reinforced to provide
Level surfaces, resistance to vibration and rigidity during transportation or installation. The perimeter of all doors and removable cover plates shall be provided all around with Neoprene perimeter of all doors and removable cover plates shall be provided all around with Neoprene.
Lifting hooks shall be provided. All hardware shall be Zinc plated and passivated.

Mounting height of components requiring operations and observations shall not be lower than 350 mm and higher than 1800 mm.

Feeder doors shall be interlocked with isolator switches so that, the door should not open when
the feeder is ON.

Base frame shall be of ISMC-100 channels with 4 Nos. Holes to suit M12 foundation bolts.

All panels' feeders shall be fully DCS compatible. It shall have sufficient potential free contacts for digital signals as per our control circuits. From SCADA It should also be possible to
control various functions of panel feeders through hardware connections.

Provision shall be made for cable entry.

Space heater with thermostat and lamps for interior illumination shall be provided for each column section of panels wherever is required.

All the panels shall be Free Standing, Floor mounted, Dead Rear type, common base frame (Internal open). The entire load bearing members shall be 2.0mm thickness sheet steel and all non-load bearing members shall be 1.6 mm thickness. All the panels shall be dust and vermin proof to meet with IP42 protection.

The cable entry shall be from bottom only. Suitable removable gland plate shall be provided.

All the Busbars, whenever used shall be of copper material only. Terminations shall be ferruled and Properly numbered.

The earthing arrangements shall be as per IEC standards which shall be furnished by you at the time of approvals.

All VFD panels shall be individual floor mounted type.

PAINTING: Exterior & Interior of the panel shall be painted with RAL-7032/7035 shade with MATT finish applicable as per IEC standards Powder coated (Nine tank process). All panels shall be protected against corrosion and sea. Base frames shall be painted with black.

Tests and Inspection:- Routine tests shall be conducted as per IEC 146. Required Control & Communication cables between VFD panels to plant DCS shall be in your scope of supply only.

1) **Moulded Case Circuit Breaker (MCCB).**
   (ff)

The circuit breaker shall conform to IEC 60947-2 and having rupturing capacity as specified in
specification sheet and mounted on a draw out chassis.

The circuit breaker shall be provided with spring assisted quick make break type, manually operated trip- free mechanism, mechanical "ON, OFF" position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm switches. The MCCB chassis shall be provided with service, test and

isolated
position and automatic safety shutter.

The thermal and short circuit tripping devices shall be adjustable type.

When used for motor circuits, shunt trip device shall be provided and the let through power of controlling MCCB shall be lower than the respective contactor.

In addition, under voltage trip shall be provided, if specified in the specification sheet.

2) Switches / MPCB.

(gg)

The switches/MPCB shall be motor duty type AC 23 category and Class-III (AC-3) duty type Comply with the requirements laid down in IEC 60947-3. Switches upto 63 Amps shall be rotary type and those of 100 Amps and above link type with Type-II coordination. Shall be consider MPCB's upto 30HP rating and SFU's for the above rating.
"ON and OFF" position of the switches shall be indicated on the module. Provision shall be made to Lock the switch in the "OFF" position. Switch ON/OFF feedback PF element shall be provided.

The fixed contacts shall be shrouded type. The moving contacts shall be silver-plated.

3) Fuses.

The fuses shall be of non-deteriorating HRC cartridge link type and shall conform to IEC 60947-3. They shall be suitable for the load and service required in the circuit.

4) Air Break Contactors.

The Air break contactors shall be of Class III, Category AC3, unless otherwise specified, conforming to IEC 60947-4-1 and flapper type with type-II coordination.

Each contactor shall be provided with auxiliary contacts as required. The rating of the auxiliary
contacts shall be 5 Amps AC or 1 Amp DC at the specified control voltages. Spare contacts shall be wired to the terminal blocks.

5) Bimetal Thermal Overload Relays

The contactor shall be provided with three pole bimetal thermal overload relays, unless otherwise specified. The bimetal relays shall be of suitable range, ambient temperature compensated and shall be separate mounting type. They shall be adjustable through graduated scale and shall be provided with change-over contact. Thermal relays having long time / current characteristics operated through saturated CTs shall be supplied, wherever required.

Bimetal thermal relays shall conform to IEC 60898 and shall have built-in Single Phasing Preventer.

The bimetal relays shall be provided with a manual-resetting device, resistible after opening module door. Auto reset thermal relays are not acceptable.

6) Panel Wiring

Wiring shall be carried out with 650/1100-volt grade, single core, stranded copper conductor wires with PVC insulation. The minimum Size & Code of stranded copper conductor for wiring shall be as follows:

Control AC circuit - 1.5 mm^2 Black Flexible.

CT circuit - 2.5 mm² Black Flexible.
For R-Phase - CT-Red Sleeve
For Y-Phase - CT Yellow sleeve
For B-Phase - CT Blue Sleeve
For Neutral of CTs - Green Sleeve
Potential circuit - 1.5 mm² Red, Yellow, Blue and Black Flexible.
DC circuit - 2.5 mm² Grey Flexible.
For Positive – Red Sleeve
For Negative – Black Sleeve
Earthing circuit - 2.5 mm² Solid Green Flexible.

Panel wiring shall be securely supported, neatly installed by lacing and tying or in wiring channels. Flame retardant, plastic wiring channels / troughs with strap on wiring covers shall be used.
Terminals for A.C. supply and D.C. supply shall not be terminated on adjacent terminal blocks.

All spare contacts of breakers, switches, push buttons and relays shall be wired to terminal block.

Wiring terminations shall be made with solderless, crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at the wire terminations. More than one control wire should not be crimped together. Engraved core identification plastic ferrules, marked to correspond with the panel wiring diagram shall be fitted at both ends of wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected.

7) **Terminal Blocks**
(hh)

All the terminal blocks shall be Elmex make CATM4 type and for disconnecting type terminal
blocks (CT terminal blocks) shall be CATDM4 type.

At least 20% spare terminals shall be provided and these shall be uniformly distributed on all rows of terminal blocks.

There shall be minimum clearance of 250 mm between the first row of terminal block and associated cable gland plate for easy termination of cable. The clearance between two rows of terminal block shall be minimum 150 mm.

8) **Labels**
(ii)

All front mounted equipment as well as equipment mounted inside the panel shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment.

Labels shall be provided at the rear / inside the panel for all front mounted equipment. It shall be
mounted by the side of the respective equipment wiring. The labels shall correspond to wiring diagram and GA.

Label shall be made of non-rusting metal or 3-Ply lamicoid. Labels shall have white letters on black background. Labels shall be fastened using screws. Use of adhesive is not permitted.

9) Earthing.

(jj)

The panel shall be fitted with an earth bus, securely fixed along the inside base of the panel. Earth Busbars shall be inside the panel only. Material and size of earth bus shall be as specified in the specification sheet.

All metallic cases of relays, instruments and other panel-mounted instruments shall be connected to earth bus by independent insulated copper wires as per applicable standards.

PT and CT secondary neutral or common lead shall be earthed at one place only at the terminal
blocks where they enter the panel.

Insulation between the live terminal and earth prior to connection of the earth to the Purchaser's
earth grid shall withstand a test voltage of 500V for one minute (or have resistance of not less than one mega Ohm of 500V).

10) PAINTING

(kk)

Exterior & Interior of the panel shall be painted with light Siemens gray of shade No.631 IS 5, Powder coated (Seven tank process). All panels to be protected against corrosion.
Base frames shall be painted with black.

11) Inspection & Testing

(ll)

We / our client's representative will visit works during manufacturing to assess the progress of
work as well as to ascertain the quality as per the approved QAP.

The following typical **TYPE TEST** reports shall be submitted along with the bid.
A. Verification of Temperature Raise limits.
B. Verification of Dielectric properties.
C. Verification of Short circuit strength.

All Routine tests shall be performed at your works as per relevant IEC 60439-1/EN 60439-1norms.
All routine test certificates shall be submitted to our consultant for his approvals prior to dispatch of the equipment.

We / our client reserve the right to witness final test at the works. To enable us to depute our representative, prior notice as agreed shall be given by the vendor.

Inspection by us, however will not absolve the vendor from their responsibility for good design,
material and for the satisfactory performance of the equipment and as such, they have to make good any defects noticed subsequently.

12) Quality Assurance Plan

(mm)

The panel shall be manufactured as per approved supplier QAP.

(nn)

(oo)

(pp)

VARIABLE FREQUENCY DRIVE

2.1.56. GENERAL FEATURES

(qq) This feature is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter. Configuration of a variable frequency drive is as follows:

a. Automatic Voltage Regulation (AVR) function
b. Automatic PFI regulation function
c. Auto energy savings mode
d. Four line digital display with info key (for four parameters)
e. Dual rating design (Light duty & Normal duty)
f. Built-in real time clock
g. Hot plug LCD keypad offers a user-friendly operation interface. The display screen can be defined by the user with customized software & adjustable pulse frequency
h. Networking drives system
i. Built-in Automation Application
j. Design should be flexible and ease maintenance

(rr)

2.1.57. PRODUCT QUALITY STANDARD

a. National Electric Manufacturers Association (NEMA)

(ss) Or Under writers Laboratories Inc (UL)/CSA

b. CE low voltage directive EN50178 Electrical Equipment for use in power installation

(tt) Or EMC Directive 89/336/EEC or 2004/108/EC (See also EN 5008102 and EN 50082-2).

(uu)

2.1.58. MAIN CONTROL FUNCTIONS

a. Fault Reset
b. Speed Search
c. S-curve Acceleration/Deceleration control
d. Slip Compensation
e. PID control (with slip function)
f. Parameter Copy
g. Energy Saving mode
h. 3-wire Sequence
i. Torque Compensation
j. Torque limit
k. Over torque Protection
l. Auto tune (rational and stationary)
m. JOG frequency control
n. MODBUS Communication (RS-485)

(vv) Communication loss functionality to ensure uninterrupted operation. It shall be possible to set the VSD to change the control location from PLC to other external location

identified by user, e.g. drive's embedded PID/loop controller and change back when communication is recovered.

o. Frequency Upper/lower limit setting

p. Momentary power loss ride through Acceleration/Deceleration. Time Switch

(ww) The VSD shall include a switching frequency control function. This reduces the switching frequency, based on actual VSD temperature and allows the highest carrier frequency without de-rating the VSD or operating at high carrier frequency only at low speeds (temperature fold-back). It shall be possible to set a minimum and a reference switching frequency.

q.Cooling Fan Auto mode

r.DC injection braking at start/stop

s.Variable Frequency Drive (VFD) Efficiency: Above 98%

t.Auto phase sequence changing mode (Forward/Reverse rotation mode)

~~(xx)~~ The VFD should have IEC 60721-3-3. Class 3C2 as standard Class 3S2 (solid particles) coated boards as standard delivery.

u.The VFDs shall have in-built Dry pump protection and end of curve protection, Flow Compensation and No flow detection features.

v.The VFDs shall have in-built sleep mode and Auto tuning of the PI controllers

w.Harmonic Current suppression (DC Reactor Facility)

(yy) The drive shall be equipped with a dynamic control solution that adapts to changes in the motor load and reduces the energy needed to deliver the required torque.

x.The VFD should have the option to use up to cable length minimum 150 meters without additional output choke and above 150 meters to 450 meters with additional output choke.

(zz)

2.1.59. GENERAL SPECIFICATION:

a. Input Phase : Three Phase

(aaa) Frequency: 50 Hz

b. VFD Capacity : 110±3% kW (106.70 kW to 113.30 kW)

c. VFD efficiency: ≥98%

d. Input Voltage Range:

(bbb) 380 to 480 VAC, +10%...-15%

(ccc) Power Factor (cos Φ) at nominal load 0.98

e. Output Frequency: 0 to 320 Hz

f. Frequency Resolution Digital Command: 0.01 Hz

g. Analog Command: Maximum output frequency x 0.03/60 Hz (±11 bit)

h. Carrier Frequency Range: 2 ~ 15 kHz (depends on motor output)

i. Input Frequency Tolerance: 50 ±5% Hz

j. Frequency Setting Signal: 0 ~ 10 V, 4 ~ 20 mA. Analog Signal

k. Control mode: V/F control, sensorless Vector control (SVC)

l. Acceleration/Deceleration Time: 0.01~360/0.01~360 seconds (Adjustable)

m. Communication Protocols: Built-in (RS-485, MODBUS, BAC net)

n. EMI Filter: Built-in (Standard IEC 61800-3:2004,C2)

o. Harmonics Filter:

(ddd) Built-in swinging choke as standard and shall meet the requirements of IEC 61000-3-12: 2011. The chokes shall be capable of delivering 25% fewer harmonics at partial loads.

p. Restart after instantaneous power failure: Up to 15 Seconds (Auto/Manual)

q. Cooling Method: Fan Cooling

r. Short circuit current rating: ≥ 100 KA (50,000 AMP)

(eee)

2.1.60. SAFETY PROTECTION:

(fff) The VSDs shall support 'Safe Torque Off' (STO) function capable for safety related applications up to SIL 3, SILCL 3 and PL e.

(ggg) There shall be 3rd party statement of compliance available to confirm VSD compliance. Manufacturer's statements are not accepted to confirm compliance.

a. Motor Protection: Electronic Thermal Relay Protection
b. Over Current Protection for 150% of rated current
c. Over Voltage Protection: For 1(one) Phase (230Vac): Drive will be stopped when input voltage exceeds 20% of the rated Voltage. For 3(three) Phase (410Vac): Drive will be stopped when the input voltage exceeds 20% of the rated Voltage.
d. Overload Tolerance: Light Duty: 120% of rated current for 1 minute:
e. Normal Duty: 120% of rated current for 1 minute;
f. 160% of rated current for 3 Seconds
g. Over Temperature Protection: Built-in temperature sensor
h. Torque Limit Normal Duty: Maximum 170% torque current

(hhh)

2.1.61. ENVIRONMENTAL PROTECTION:

a. Ambient Temperature (Storage/Transportation: 0°C- +50°C without derating
b. Air Pressure (Operating/Storage): Atmospheric Pressure
c. Pollution Level: Class 3C2: Class 3S2 (Operation), Class 2C2:Class 2S2 (Storage)
d. Protection Level: Minimum IP 20/UL Open Type (above 45 kW)
e. Sound Level: Up to 75 db
f. Humidity: Up to 95%
g. Allowable maximum temperature rise inside the panel box: ≤ 15 °C

L. T. PANELS / P.C.C. / M.C.C.

This scope shall cover design, manufacture, check test, and supply, installation, testing (Scope to assist the Ele.Contractor for installation, all the sections of panels & Internal Control wiring should be done by panel vendor on site), testing and commissioning of various medium voltage Panel Board as described in Bills of quantities and drawings. The Panel manufacturer should have a design validated by CPRI / ERDA for breaking capacity of at least 100 KA for 1 Sec.

Panels shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system, neutral grounded at transformer. All Distribution panels shall be CPRI approved and / or manufactured by an approved manufacturer.

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

9.6.1 SERVICE CONDITIONS AT SITE

Ambient Temperature: Max. / Min. = 55° C. / 3° C.

Design temperature: 60 Degree C.

Relative humidity: 100%

Voltage: 415+/- 10%, TPN
Frequency: 50 Hz. + 3% to -6%
Neutral: Solidly / earthed neutral.
Fault level: 18.4KA, Symmetrical at 415V solidly earthed.

9.6.2 GENERAL SPECIFICATIONS:

All the Panels shall be metal clad, totally enclosed, rigid, floor / wall mounting, air insulated, cubicle type suitable for operation on three phase / single phase, 415 V / 230 V / 240 V, 50 Hz., neutral effectively grounded at transformer and short circuit level.
Degree of protection for following type of distribution panel enclosure shall be as per IS:13947-1993. IP 52 for indoor panels. The painting of all the metal part shall be with seven tank process followed by powder coating as per the standard. The Panels shall be designed to withstand the heaviest condition at site, with maximum expected ambient temperature of 50° c., 95% humidity.

9.6.3 STANDARDS AND CODES:

The Panels shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian standards shall be complied with:

STANDARD NO.	PARTICULAR
IS: 4237	General requirements for switchgear and control gear for voltages not exceeding 1000 V a.c. or 1200 V d.c..
IS: 5578	Guide for marking of insulated conductors.
IEC 61439-1&2	Specifications to Low-voltage switchgear and control-gear assemblies
IS/IEC 60947-2: 2003	Low Voltage Switchgear & Controlgear, Circuit Breakers
IS 2147-1962	Degree of protection provided by enclosure for Low Voltage Switchgear & Control-gear
IS 3043	Earthing codes
IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus Terminals.
IS: 13947	Low voltage switchgear and control gear.
IS: 8197	Terminal marking for electrical measuring instrument and their accessories.
IS: 2551	Danger notice plates
IS: 10118	Code of Practice for selection, installation and maintenance of switchgear and control gear
IS: 8623	Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000 V A.C. and 1200 V D.C.
IS: 8828	Miniature circuit breakers.
IS: 9224	HRC fuse links
IS: 2705	Current transformer
IS: 3156	Voltage transformer

STANDARD NO.	PARTICULAR
IS: 3231	Electrical relay for protection
IS: 1248	Indicating instrument
IS: 722	Integrating instrument

Indian Electricity Act and Rules (as amended up to date) and approval of FIA of India.
The Panels also require approval of the consultant at various stage of their manufacture such as design, selection, construction, testing, shipping etc..

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

2.1.62. TECHNICAL PARAMETERS

System Details

- System Voltage : 415V ± 10% 3-phase, 4 wire solidly grounded
- Frequency : 50Hz ± 3%
- Control Supply : 230 Volts AC ± 10% (tapped from phase & neutral) 110V DC ± 10%

2.1.63. STRUCTURE :

- The PCCs, MCCs & PDBs shall be metal clad enclosed and be fabricated out of high quality CRCA sheet, suitable for indoor installation, front operated and floor mounting type.
- CRCA sheet steel used in the construction of PCCs / MCCs / PDBs shall be 2 mm thick for structure, 1.6 mm thick for doors, covers shrouds and 3 mm thick for gland plate and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.
- The PCCs / MCCs / PDBs shall be totally enclosed, completely dust and vermin proof and degree of protection being no less than IP-54 confirming to IS 2147. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketted with neoprene gaskets and shall be lockable.
- All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screw shall enter into holes taped into an adequate thickness of metal or provided with bolts and nuts. Self-threading screws shall not be used in the construction of PCCs / MCCs / PDBs.

- A base channel of 75 mm x 75 mm x 5 mm or as per the weight of the panel shall be provided at the bottom.
- PCCs / MCCs /PDBs shall be arranged in multi-tier formation. The PCCs / MCCs / PDBs shall be of adequate size to facilitate enough space for maintenance and cooling. The size of the PCCs / MCCs / PDBs shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component does not attain temperature more than 40 degree Celsius. Openings shall provide for natural ventilation, but the said openings shall be screened with fine weld mesh.
- Knockout holes of appropriate size and number shall be provided in the PCCs / MCCs/ PDBs in conformity with number, and size of incoming and outgoing conduits / cables.
- Alternatively the PCCs / MCCs / PDBs shall provided with removable sheet plates at top and bottom to drill holes for cable / conduit entry at site.
- The PCCs / MCCs / PDBs shall be designed to facilitate easy inspection, maintenance and repair.
- The PCCs / MCCs / PDBs shall be sufficiently rugged in design and shall support the equipment without distortion under normal and short circuit condition they shall be suitable braced for short circuit duty.

2.1.64. PROTECTION CLASS:

(iii) All the indoor PCCs / MCCs / PDBs shall have protection class of IP - 54

(jjj)

2.1.65. POWDER COATING:

All sheet steel material shall undergo seven-tank process after all the necessary shearing and other mechanical works are completed. After the seven-tank process powder coating treatment shall be adopted using powder of reputed make. After the powder coating is complete welding in the panel or any sort of shearing, bending or cutting activity shall not be done. The colour shall be Siemens Grey 631

2.1.66. CIRCUIT COMPARTMENT:

Each circuit breaker and switch fuse units shall be housed in separate compartments and shall be enclosed an all sides. Sheet steel hinged lockable door shall be duly inter locked with the breaker / switch fuse units in ON and OFF position. Safety interlocks shall be provided for non-opening of the door when the breaker is in ON position.
The door shall not form integral part of the draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tires in a vertical section.

2.1.67. INSTRUMENT COMPARTMENT :

Separate and adequate compartment shall provided for accommodating instruments, indicating lamp, control contactors, relays and control fuses etc. These components shall be

accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, switch fuse units, bus bars and connections.

2.1.68. BUSBARS :

Bus bar and interconnections shall be of high conductivity electrolytic grade copper as indicated in the bill of quantities complying with requirement of IS: 5082 – 1981 and of rectangular / Square cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded.
Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by connected by means of bus bar connectors to avoid tapings on solid bus bars. Additional cross-sectional area to be added to the bus bar to compensate for the holes if required. All connections between bus bars and breakers shall be through solid / Flexible copper strips of proper size to carry full rated current and insulated with insulating sleeves.
The busbar shall be air insulated and made of high quality, high conductivity, high strength electrolytic grade Copper. The busbar shall be of 3 phases and neutral system with separate neutral and earth bar. The size of neutral busbar in all panels or lighting panels and feeders shall be equal to phase busbar. The busbar and interconnection between busbars and various components shall be of high conductivity Copper.
The busbar shall be of rectangular / square cross-section designed to withstand full load current for phase busbars and half rated current for neutral busbars in case of APFCR panels only and shall be extensible on either side.
The busbar size shall be as per drawing. The busbar shall have uniform cross-section throughout the length. The busbars and interconnections shall be insulated with epoxy coated bus sleeves. The busbar shall be supported on glass fiber reinforced thermosetting plastic insulated supports type at sufficiently close intervals to prevent busbars sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 18.4 KA RMS symmetrical for 1 sec.
The busbar shall be housed in a separate compartment. The busbar shall be isolated to avoid any accidental contact. The busbar shall be arranged such that minimum clearances between the busbars are maintained as below:
Between phases : 30 mm. minimum
Between phases and neutral : 30 mm.
Between phases and earth : 30 mm.
Between neutral and earth : 30 mm. Minimum
Busbar shall be calculated on 55 deg. C. ambient temp. and 85 deg. C. for continuous and short time rating Busbar surrounding air temperature shall be considered 70 deg. C. for busbar calculation
All joint shall have non-flammable insulation shrouds for secondary insulation purpose

2.1.69. TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993. All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final

Distribution boards shall be provided with Miniature Circuit Breakers. Final Single-Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers.

All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed. Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

2.1.70. ELECTRICAL POWER & CONTROL WIRING CONNECTION :

Terminal for both incoming and outgoing cable shall be suitable for 1100 volts grade, aluminum/copper conductor PVC insulated and sheathed, armoured cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawing for the PCCs, MCCs, PDBs.
Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance.
Both control and power terminals shall be properly shrouded.
10% spare terminal shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire connected per terminal.
Terminal strip for power and control shall preferably be separated from each other by suitable barriers of enclosures.
Wiring inside the module for power, control protection and instrument etc. shall be done with use of 1100 V confirming to IS 694 and IS 8130. Power wiring inside the starter module shall be rated for full current rating of contactor, but not less than 4 sq mm cross section area. For current transformer circuits, 2.5 sq mm-copper conductor wire shall be used. Other control wiring shall be done with 1.5 sq mm copper conductor wires. Wires for connections to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.
Control power for the motor starter module shall be taken from the respective module switchgear outgoing from R phase and Neutral. Control wiring shall have control fuse (HRC type).
Particular care shall be taken to ensure neat and orderly laying of the wiring. Identification ferrules shall be tagged to all the wire termination for ease of identification and to facilitate and testing.
"CUPAL" washers shall be used for all copper and aluminum connections.
Final wiring diagram of the PCC, MCC, PDB power and control circuit with ferrules number shall be submitted along with the PCC/MCC/PDB as one of the documents.

2.1.71. TERMINALS :

The outgoing terminals and neural link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformer for instrument metering shall be

mounted on the disconnecting type terminal blocks. No direct connection of incoming and outgoing cables to internal components connection of the distribution board is permitted. Only one conductor may be connected in one terminal.

2.1.72. WIREWAYS :

A horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

2.1.73. CABLE COMPARTMENT:

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables. Minimum 200 mm gap should be provided in the Panel from Metal Enclosure Gland plate to Polycarbonate Cable compartment gland plate. In Polycarbonate Cable compartment minimum 150 mm gap should be provided from bottom of the cable connector. Minimum 75 mm gap Should be provided between connectors of every cable. All the cable gland plate should be detachable (on both Panel enclosure as well as Internal IP 65 Box). Provide glands at both the detachable gland plate to maintain complete IP 65. All cable terminals should be of Hensel / Spelsberg make only & Terminal size should be 2 sizes higher than required current capacity.

2.1.74. EARTHING :

Copper earth busbar of minimum 25 mm x 6 mm size shall be provided in the PCCs & MCCs for the entire length if panel. As per the rating of the main busbars the size of earthing busbar shall be decided. The framework of the PCCs & MCCsshall be connected to this earth busbar. Provisions shall be made for connection from earth busbar to the main earthing bar coming from the earth pit on both sides of the PCCs, MCCs, PDBs.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp and the clamp shall be ultimately bounded with the earth bar.

2.1.75. LABELS:

Engraved Aluminium sheet labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

2.1.76. NAME PLATE :

A name plate with panel designation in bold letter shall be fixed at top of the central in panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartment, the electrical component, equipments, accessories like switchgear, contactor, lamp, relays etc. shall suitably be identified by providing stickers. Engraved nameplates shall be of Aluminium strip of black colour and silver letters format.

Nameplate shall be fastened by counter sunk screws / riveted and not by adhesives.

2.1.77. DANGER NOTICE PLATE :

The danger plate shall be affixed in a permanent manner on operating side of the panel.
The danger notice plate shall indicate danger notice both in Hindi and English and with a sign of skull and bones.
The danger notice plate in general shall meet to requirements of local inspecting authorities.
Overall dimension of the danger notice plate shall be 200 mm wide and 150 mm high. The danger notice plate shall be made from minimum 1.6 mm thick mild steel sheet and after due pretreatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.
The letter, the figure, the conventional skull and bones shall etc. shall be positioned on the plate as per recommendations of IS : 2551-1982.
The said letter, the figure and the sign of skull and bones be painted in single red colour as per IS: 5-1978.
The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit design of the panel.
The danger notice plate, if possible, be of ISI certification mark.

2.1.78. INTERNAL COMPONENTS:

The PCC / MCC / PDB shall be equipped complete with all type of required number of air circuit breakers, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the PCC / MCC but not indicated on the drawings shall be supplied and installed on the PCC / MCC .
All part of the PCC / MCC carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the PCC / MCC .
All units of the same rating and specifications shall be fully interchangeable.

2.1.79. MINIATURE CIRCUIT BREAKER (MCB):

Miniature circuit breakers shall be quick make and break and break type conform with British standard BS: 3871 (Part-I) 1965 and IS: 8825 (1996). The housing of MCBs shall be heat resistant and having high impact strength. The fault current of MCBs shall not be less than 10000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.
The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faulty current.

The MCB contact shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger relay for over current and short circuit protection. The over load or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested and certified as per Indian Standard, prior to Installation.

2.1.80. MOULDED CASE CIRCUIT BREAKER:

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCB's for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.

Protection Functions

- MCCB's with ratings up to 200 A shall be equipped with Thermal-magnetic (thermal for overload and magnetic for short-circuit protection) trip units
- Microprocessor MCCB's with ratings 250A and above shall be equipped with microprocessor based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable, and it shall be possible to fit lead seals to prevent unauthorised access to the settings
- Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)
- Protection settings shall apply to all poles of circuit breaker.
- All Microprocessor components shall withstand temperatures up to 125 °C

Testing

- Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished.
- Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

a) Handle interlock to prevent unnecessary manipulations of the breaker.

b) Door interlock to prevent the door being opened when the breaker is in ON position.

c) Defeat-interlocking device to open the door even if the breaker is in ON position.

- The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism.
- MCCB's shall be capable of defined variable overload adjustment. All MCCB's rated

200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.

- All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.

The trip command shall override all other commands.

2.1.81. CONTACTORS:

The contactor shall meet with the requirements of IS: 2959 and BS: 775.
The contactors shall have minimum making and breaking capacity in accordance with utilization category AC 3 and shall be suitable for minimum class II intermittent duty.
If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

2.1.82. TRIVECTOMETER:

Flush mount 96 x 96 x 80 mm load manager type Enercon EM 6400 or equivalent meter of accuracy class 1 as per IS 13779 shall be provided. The meter shall be accurate on distorted waveforms; simultaneous sampling of voltage and amperes shall be done. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios with built in phase analyser. Auto scrolling shall be programmable as per user choice and communication with PC; PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option and 10 years back up of integrated data.
Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.
User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, sliding window auto sync. And auto scrolling of parameters shall be available.
Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 7.5 A and burden on PT or CT shall be app 0.2 VA.
Accuracy for kW / kWh shall be as per IS 1377 / CBIP88 and for all other parameters shall be +/- 0.5% of full scale + 0.5% of reading + 1 digit. Digital readout shall be of 3 rows of 4 digits each (12.5 mm size) with 7 segments bright red LED. Input frequency shall be 50Hz / 60Hz +/- 5%. Power factor range shall be 0.5 lag – unit – 0.8 lead.
Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and 1 sec for other parameters. Display sequence shall be parameter followed by value.
Temperature range shall be 0-50oC and humidity <95% non-condensing.

2.1.83. CURRENT TRANSFORMER:

Where called for, CT's shall provide for current measuring. Each phase shall be provided with separate CT of class I accuracy and VA burden as shown in SLD for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 - 1964 as amended up to date.

2.1.84. PUSH BUTTON:

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip.
The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip. Push button shall be of self-glowing type with LED lamp.
Indicating Lamp shall be LED type and shall supplied complete with translucent covers to diffuse the lamp light. Indicating lamps shall be part of push buttons.
Colour shade for the indicating lamps shall be as below:
ON indicating lamp : Green
OFF indicating lamp : Red
TRIP indicating lamp : Amber
PHASE indicating lamp : Red, Yellow, and Blue.

2.1.85. TESTING

The following drawings shall be submitted before procurement for approval from the client / consultant.
1. General arrangement and Fabrication details.
2. Power wiring diagram of the panel.
3. Control wiring diagram of panel.
4. C.T. ratios with connection.
5. Material list with make, catalogue nos.

Testing and setting the relay set – point and co-ordination between relay on LT/HT fuses, breaker, setting shall be done by contractor. The downstream of the setting should be provided.
The relay should be tested by reputed agencies and test report of the relay should be submitted by the contractor.
Testing of panels shall be as per following codes:
IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
IS: 13947: 1993 Degree of protection
IS: 5578 & 11353:1985 Arrangement of bus bars.

1.1 KV & 6.35/11 KV GRADE L.T & H.T CABLES AND CABLE TERMINATION:

Technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in nonreturnable steel drums), various sizes of aluminum, XLPE insulated, voltage upto and including 1100 Volts, extruded PVC inner sheathed, extruded FRLS PVC outer sheathed, GI round wire armoured cables, suitable for solidly grounded system. The cables shall confirm to IS 7098-Part 1 with latest amendments.

Technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in nonreturnable

steel drums), 6.35 / 11 KV (E) Voltage Grade, 3-Core, 400Sq. mm Stranded Compacted Circular Shaped Aluminum Conductor of H4 Grade, Shielded with extruded Semi-conducting compound, XLPE insulated, PVC sheathed, GI Round wire armoured Power Cables for effectively grounded system. The cable shall confirm to the latest revisions of IS: 7098 (Part –2).

2.1.86. GENERAL TERMS & CONDITIONS

1. Climatic Condition: The site is located about 500 meters from the seacoast and the atmosphere is laden with salt spray. The climate is tropical with high humidity, heavy rainfall and prone to rust and fungus growth
2. Ambient Air Temperature:
   i. Maximum 45^0C
   ii. Maximum Daily Average 40^0C
   iii. Max. Weighted Yearly Average 32^0C
   iv. Max. Relative Humidity 90%

The maximum temperature and relative humidity likely to occur simultaneously are 420C and 80% respectively

3. Installation Location: The cables may be laid/buried directly in ground, covered cable trenches, Cable racks/ladders in open air

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(lll)

2.1.87. 1.1 KV,6.35 / 11 KV (E) GRADE, ALUMINUM CONDUCTOR, POWER CABLES

This section covers the technical specifications for design, engineering, manufacturing, inspection, testing at manufacturer's works, packaging and delivery by road (properly packed in non-returnable steel drums), 1.1KV & 6.35/11 Kv grade, Multi-stranded Aluminum conductor, XLPE insulated, extruded PVC inner sheathed, GI round-wire armoured, extruded FRLS PVC ST2 outer sheathed. Power Cables for effectively grounded system, conforming to the latest revisions of IS: 7098 (Part –I), 1988 & as per the technical specifications attached herewith.

2.1.88. STANDARDS

The design, manufacture and testing of the cable shall comply with the latest editions/amendments of the following Indian Standards, unless otherwise specified. Equipment's complying with equivalent standards shall also be acceptable.

IS-7098, 1998 (Part-I): Cross linked polyethylene insulated PVC sheathed cables for working voltages upto 1100V.

IS-7098 (Part –2): Specification for cross linked polyethylene insulated PVC sheathed cables for working voltages from3.3 kV up to and including 33 kV

IEC-60502-2 1998: Power Cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV

IS-5819: Recommended Short circuit Current ratings for High voltage cables

IS-396: Recommended current ratings for cables

IS 8130-1984: Specification for conductors for insulated electric cables and flexible (mmm) cords.

IS-3975, 1999: Low Carbon galvanized steel wires, formed wires & tapes for (nnn) armoring of cables

IS-4759: Specifications for Hot dipped galvanized coating on round steel wires

IS-5831: PVC insulation and sheath of electric cables.

IS-10418: Drums for electric cables.

IS-10810 (Part 0 to 64): Method of test for cables.

2.1.89. SERVICE CONDITION

The cable shall be designed with the following service conditions into consideration:

a) Cables shall be capable of satisfactory operation under a power supply system frequency variation of +3% and voltage variation of ±10%.
b) Cables shall be suitable for laying in conduits, ducts, trenches, channels, trays, racks or for direct buried in ground in both dry and wet locations with chances of flooding by water.
c) The cables shall be suitable for the following ambient condition: Ambient Air temperature: 400C
d) Ambient ground temperature: 300C
e) The current rating shall be based on maximum conductor temperature depending on the type of insulation for continuous at the rated current.
f) The one second short circuit current rating values shall be furnished and shall be subjected to the purchaser's approval.
g) The cables will have current ratings and de-rating factors as per relevant Indian Standards.

Full technical details and descriptive literature shall be furnished indicating the construction details, standard applicable for the components of the cable and current ratings of the cables in air and ground. De-rating factors to be considered for the ambient temperature, ground temperature, de-rating due to cable location in air and ground shall also be furnished. The certificates for the type tests conducted on cables similar to the cables covered herein shall be submitted along with the tender.

2.1.90. DESIGN AND CONSTRUCTION PERTICULARS

- **General**

The cables supplied under this specification shall be adequate insulated to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of the cables. The sheathing material shall be high quality PVC based compound. The construction of cable shall be as per IS: 7098 (Part I &2) – 1988. Cable shall be designed and manufactured to prevent damage during transportation, installation & operation under all climatic & operating conditions to which cable may be subjected to.

9.5.1 Technical parameters
(ooo)

- **Cable Insulation Level**

The power cables shall withstand power frequency voltage, impulse voltage and partial discharge extinction level as per IS: 7098 part – 2.

- **Cable Current Carrying capacity**

The cable shall be suitable for use where combination of ambient temperature and temperature rise due to load, results in conductor temperature not exceeding 90oC under normal operation. The cables shall have the following continuous current ratings when laid in ground 1100 mm below ground level and in air with the ground temperature being 30oC and air temperature being 40° C and assuming that thermal resistivity of soil is 150°C.cm/W and a maximum operating temperature of 90o C.

- **Cable Short Circuit withstand capacity**

The cable shall withstand the short-circuit current of 11Kv-31.5KA & 415V -25KA for 1 second, assuming the initial conductor temperature of 90° C and final temperature of 250° C.
The cables shall be suitable for Voltage grade 6.5 / 11 KV (E) & 650/1100 VOLTS, 3 phase, 50 Hz frequency, effectively grounded system and capable of continuous operation at their rated currents.

- **Cable Voltage Rating**
  - **Conductor**
    - ALUMINIUM

The Aluminium conductor used shall be of H-4 grade (Tensile strength above 150 N/mm2). High conductive aluminium, stranded (Class-II, stranded circular shaped), uniform in quality and free from scale, inequalities, spills, splits and other defects. The aluminium used shall have purity meeting the criteria for maximum resistance allowed. *Two sample conductor randomly selected from finished lot of cables, shall be tested for its purity at any 3rd party NABL accredited lab.*

- **Cable Joints:**

Joints shall be permitted in the individual wires of which the conductor is formed, but no joint shall be within 300 mm of any other joint within the same layer. The joints shall be made by resistance butt welding, fusion welding, cold pressure welding,
electric welding, gas welding, brazing or silver soldering. No joint is allowed in the conductor after stranding. A maximum of two joint shall be allowed in any strand forming complete length of the cable.

The conductors shall conform to appropriate dimensions, resistance and number of wire in the conductor (number of strands) as given in IS 8130 (Part I): 1984.

- **Conductor Screening**

The Conductor screening shall be provided over the conductor by extrusion of semiconducting compound and shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damaging the conductor. Strippable screening shall be provided. The screening material shall be non-metallic semi-conducting compound.

- **Insulator**

The conductor insulation shall be of extruded layer of water tree free cross-linked polyethylene (XLPE), meeting the requirements of IS: 7098 (part–2). The method of cross-linking of polyethylene shall be indicated in the offer. Cross linking will be by Dry Gas Curing process.
The average thickness and tolerance of insulation when measured in accordance with IS shall not be less than the values specified in IS: 7098- Part -2.

- **Insulator Screening**

Insulation screening shall be by means of extruded bonded strippable semi-conducting layer followed by a semi-conduction-water swell able tape and metallic screening by means of wrapped copper tape.
The cable core shall be triple extruded and cross-linked in fully enclosed process such that the inner semiconducting screen, XLPE insulation and outer semi-conducting screen are applied simultaneously on the pre-heated cable conductor. In-line inspection mechanism shall continuously monitor the dimensional accuracy of the extruded core.
The cable will be tested for partial discharges after application of the copper tape screen as part of the Quality Control Procedure.

- **Insulation**

The insulating material for power cables shall be extruded cross-linked polyethylene (XLPE) compound as per **IS-7098(Part-I)-1988**. The minimum thickness of insulation shall not be less than the values specified in Table-2 of IS-7098 (Part-I)- 1988. No negative tolerance shall be applicable for the thickness. The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions.
The cores shall be identified as per the following
colour scheme:
3-Core - Red, Yellow & Blue
3 ½ or 4-Core - Red, Yellow, Blue & Black

- **Core Layout**

The core identification for the 3-core cable shall be done by using coloured strips of Red, Yellow & Blue colours respectively for each phase. The three cores shall be laid up together with a suitable right hand lay as per IS: 7098 (Part-2).
The interstices shall be filled with Non-hygroscopic material. The filler at the centre of the three cores shall be of vulcanised rubber. The filler shall be fresh material, recycled PVC material is not acceptable. The filling material shall be suitable for the operating temperature of the cable and compatible with the insulating material. The filler material should be non-hygroscopic, fire retardant and compatible with sheath.

- **Inner Sheath**

The inner sheath shall be extruded FRLS PVC, Type ST2, compatible with thermal rating of insulation conforming to IS-6380-1984. The sheath shall have adequate thickness, mechanical

strength and elasticity, as specified in IS 5831. The material shall be soft thermoplastic type, applied by extrusion method. The thickness of the inner sheath shall be as per IS: 7098 (Part I & II) and the color of the inner sheath shall be Grey. The inner sheath shall be so formed that it fits closely on the laid up cores and could be easily removed without damaging insulation. One or more layer of proofed plastic tape shall be provided over the laid up core before extrusion.

- **Armouring**

The armouring arranged over the inner sheath shall consist of one layer of galvanized round steel wires for all sizes of cable. The armour round wire used on the cable shall conform to IS: 3975 for all requirements. The direction of lay of armour shall be opposite to that of the cores. The zinc coating on the galvanized steel strip shall comply with relevant standards. The joints in armour wires/strips shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire/strip shall be at least 300 mm away from the nearest joint in any other wire/strip in the completed cable.

- **Outer Sheath**

Extruded outer sheath shall be provided over the armouring. The material used for sheathing shall be FRLS PVC sheath, Type ST-2 base compound conforming to IS 1554/ IS 5831 for power cable. The outer sheath shall be so formed that it fits closely on the laid up armour and could be easily removed without damaging the intermediate sheath and insulation. The colour of the outer sheath shall be black. The thickness of outersheath shall be in accordance with the IS 1554 (Part-I & II)-1988. Suitable additives shall be added to prevent attack by rodents and termites. All serving must be given anti-termite treatment. The PVC compound used shall be abrasion proof, chemical resistant, provide protection against ants, termites, rodent and fungal growth.

Cables shall have suitable fillers laid up with the conductor to provide a substantially circular cross section before the sheath is applied. Fillers shall be suitable for the temperature of the cable and compatible with the insulating material. The material shall be of the best quality and workmanship. The fillers and sheath material shall be non-hygroscopic. All materials shall be new, unused and of the finest quality.

- **End Sealing, Joining and Joining Material**
  - **End Sealing Materials:**

The two ends of the cable shall be sealed by means of non-hygroscopic sealing materials preferably by Heat shrinkable end caps. Each drum shall be supplied with two numbers additional heat shrinkable end caps.

- **Jointing & Jointing Materials:**

Supplier shall indicate jointing procedures for terminal joints / straight joints of XLPE cables at motors, transformers and in switchgear. Detailed write-up shall be given along with the bid detailing the procedure for jointing along with drawings.

2.1.91. INSPECTION & TESTING

All the tests specified below shall be carried out in accordance with the Indian Standards by the manufacturer in the presence of Purchaser's representative. If the cable fails to pass the test specified, the Purchaser shall have the option to reject it. Shipping release shall be obtained from the Purchaser's representative. The Purchaser, however reserves the right to waive off the inspection.

The tests at works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards, in addition any

test called for by the Purchaser or his representative to ensure that the equipment being supplied fulfils the requirement of the specification. For test not covered by any code or specifically mentioned in this specification, the test procedures are to be agreed with the Purchaser.

- **Stage Inspection**

i. The Purchaser's representative shall have access to the Supplier's works for the purpose of witnessing the tests and to ascertain that the cable being manufactured conforms to the requirements of this specification.

ii. The Purchaser's representative shall have a stage inspection during the following, important stages of production processes at manufacturer's works.

a. During Triple Extrusion process.
b. The cables will be tested for partial discharges after application of the copper tape screen as part of the stage inspection.

iii. During stage inspection the following tests shall be carried out.

a. Tensile strength
b. Elongation at break
c. Hot set test
d. Permanent set
e. Partial discharge test
f. IR before and after HV test
g. High voltage test
h. Conductor resistance test.

iv. Purchaser will witness triple extrusion process. Advance intimation shall be given to the Purchaser before starting of triple extrusion process. Ensure that online thickness monitoring unit (SIKORA) is in working condition. If online thickness monitoring unit is not working at triple extrusion point then production and as well as stage inspection shall not be carried out.

v. The customer will see the stabilizing point during triple extrusion process. Bubbles and other uneven surfaces shall not appear on the cable coming out of CCV line. If any bubbles or any other abnormality observed on the triple extruded single core cable at the end of the triple extrusion process then upto that point cable shall be cut and shall not become part of supply.

vi. After completion of water cooling of triple extruded line, residual moisture on the cable shall be removed with sufficient number of heaters. At the end of the CCV line, heaters in all the angles shall be placed to remove the residual moisture on the cable.

vii. Hot air blower shall be provided at the end of the CCV line, so that moisture on surface of the triple extruded core will get evaporated. It has to be ensured that there shall not be any water on surface of the core of the cable before winding it on to a cable drum. Sufficient delay (1 day) shall be given between end of triple extrusion process and winding of water swellable tape. & copper foil. (To avoid trapped moisture in copper foil).

- **Pre-Dispatch Inspection**

The manufacturer shall be given at least 15 days advance notice prior to the commencement of testing, so that Purchaser's representative can plan to witness the tests.

All the tests indicated in the test clause of this specification shall be carried out in the presence of Purchaser's representative by the manufacturer and shall provide all the facilities and equipment for testing.

Six copies of the Test Certificate shall be furnished to the Purchaser for approval prior to dispatch of cables from factory.

Visual check to conform the details given in this specification is to be done. In addition to the above, the general workmanship of the cable drums and cables laid in drums shall be checked.

Manufacturer shall have proper test set up for testing all the routine tests & type tests on finished cables as per IEC.

- **Type Test**

Type tests on four randomly selected cable drums will have to be conducted in the presence of the department's representative. The test samples will be taken from finished cables. This test shall be in accordance to IS: 7098, Part-1,1988.

a. Test on Conductor

- · Annealing test for copper conductors
- · Tensile test for aluminium conductor
- · Wrapping test for aluminium conductor
- · Conductor Resistance Test

b. Test on Insulation

- · Physical dimension measurement
- · Tensile strength and elongation at break
- · Hot set test
- · Shrinkage test
- · Ageing in air oven
- · Water absorption test

c. Test on round Armour

- · Physical dimension measurement
- · Tensile strength
- · Elongation at break
- · Torsion test for round wires
- · Winding test for firmed wire
- · Mass of zinc coating.
- · Uniformity of zinc coating
- · Resistivity measurement, Resistance test for armour

d.Test on Sheath

- · Physical dimension measurement
- · Tensile strength & Elongation at break test
- · Ageing in air oven
- · Loss of mass in air oven
- · Shrinkage test
- · Hot deformation test
- · Heat shock test
- · Thermal stability test

e. Partial discharge test

f. Dielectric power factor test

- · As a function of voltage
- · As a function of temperature

g. Insulation resistance (volume resistivity test)

h. Heating cycle test

i. Impulse withstand test

j. High voltage test

k. Flammability test

l. Water tightness test in longitudinal and radial direction (Manufacturer shall submit detailed procedure for this test and shall take prior approval of the engineer-in-charge).

m. Conductor purity test

One sample of aluminium shall be taken from any of the finished set of cables at random and the sample shall be tested for its purity at a NABL accredited lab.

i. ***Test requirement of FRLS inner and outer sheath***

The inner and outer sheath of cables shall meet the following test requirements related to flame retardant, low smoke emission, low acid and toxic gas emission. The BIDDERs shall have proper test apparatus to
conduct all the relevant tests as per the applicable standards:
· Flame retardant test on single cable
· Oxygen Index Test
The critical oxygen index value shall be minimum 29 when tested at 27+2ºC as per ASTMD-2863
· Temperature index test
Temperature index value shall be minimum 250ºCat oxygen index of 21 when tested as per NES 715.
· Flammability test
Cables shall pass test under fire conditions as per IS-10810- Part-53. Cables shall also pass tests as per IS-10810 Part- 61 & Part-62. Flammability shall be as per IEC 332-1 and IS 694: 1990.
. Smoke Density Test
The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than
60% when tested as per ASTM-D-2843.
· Acid Gas Generation test (halogen acid gas evolution)
The hydrochloric acid generation when tested as per IEC 754-1 shall be less than 20% by weight.
· Test for specific optical density of smoke
· Anti termite and rodent property test
The sequence of electric tests shall be as per the relevant Indian/International standards. The Bidder shall submit the sequence of tests for the approval of the purchaser before conducting the tests. A copy of the adopted standard shall also be supplied.

Routine Test (On each drum)
The following routine tests shall be carried out by the Manufacturer on each and every length of the cable in the presence of Purchaser's representative at manufacturer's works.
a. Resistance test for conductors
b. Insulation resistance (Dry) test
c. High voltage test
d. Partial discharge test.

- **Conductor purity test**

Two samples of aluminium and copper shall be taken from any of the finished set of cables at random and the sample shall be tested for its purity at a NABL accredited lab.
Qualifying Criteria:
The test results should be within limits as per IS 7098. All the routine tests as per IS 7098 / IEC shall be conducted and passed as per the limits given in the standards. All the bought-out certificates will be verified, and the test results shall be as per respective standards.

- **IDENTIFICATION**

The following details shall be marked sequentially for each meter run length of the cable by non-erasable embossing on the outer sheath:
a. Reference to Indian Standard
b. Name of the manufacturer/ Trade Name
c. Name of the project: **CWMF, BARC (K)**

d. Configuration of the cable: viz. Voltage grade, no. of Core, Sq. mm, A2XWY/2XWY/YWY / YY as applicable
e. Year of manufacturing
f. Sequential marking of running meter length
The running length of the cable shall be identified at regular intervals of one meter (Increasing order from inner end to outer end of the cable.

- **PACKAGING (ppp)**
  - Each drum shall consist of single length cable ≥ 500 metres.
  - The cable shall be wound on *non-returnable steel drums* of suitable size, packed and marked.
  - Packing shall be sturdy to protect the cable from any injury during transportation, handling and storage. The cut ends of the cable shall be sealed by means of non-hygroscopic sealing material preferably Heat shrinkable end caps.
  - One end of the cable shall be brought out of the drum and suitably clamped to the drum flange with proper mechanical protection. Location of the other end may be marked on the drum.
  - The cable shall be placed on drums in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. No undue stress shall appear on cables when laid on drums.
- The cable drum shall carry the following information stencilled on a metallic label, securely attached to each end of the drum:
  i. Reference to the Indian standard
  ii. Manufacturer's name, brand or trade mark
  iii. Type of cable and voltage grade
  iv. No. of cores
  v. Nominal cross-sectional area of conductor
  vi. Cable code
  vii. Length of cable on drum
  viii. No. of lengths on reel, drum or coil (if more than one)
  ix. Gross weight
  x. Country of manufacture
  xi. Year of manufacture
  xii. Direction of rotation of drum (an arrow)
  xiii. ISI certification mark

- **PREFERRED MAKE**

Reputed brand possessing system certification of ISO 9001:2008, ISO14001:2004, OHSAS18001:2007 & EN 16001- 2009 and product certifications IS: 7098 (Part-I), CE, UL etc. Quotations without these certification details will not be considered for technical evaluation.
Preferred make of bought out material:
a. Aluminium for Conductor: Reputed brands
b. Copper for Conductor: Reputed brands
c. XLPE compound of Insulator: Reputed brands
d. Armour Steel: Reputed brands

- **GUARANTEE**

All the cables shall be guaranteed against faulty material, defective design & poor workmanship for a period of 18 months from the date of supply. The materials becoming defective during the guarantee period shall be replaced free of cost and the defects arising out of the works shall be rectified free of charge without delay.

TECHNICAL DATA SHEET

TECHNICAL DATA SHEETS FOR 6.35 / 11 KV (E) 3 CORE ARMOURED, SCREENED HT XLPE CABLES

S.No.	Description	cores x sq.mm	3 C x 400
1	**GENERAL**		
	Cable Type / Code	sq.mm.	A2XFY
	Voltage Grade		6.35 / 11 KV (E)
	Standards Applicable		IS:7098 (P-2) 2011, IS:5831-1984, IS:8130-1984, IS:3975
	Extrusion method		Triple Extrusion
2	**CONDUCTOR**	mm	
	Material		Stranded (Class 2) Compacted Circular Aluminium Conductor as per IS 8130
	Cross Sectional Area	mm	400
	Min No of strands		53
3	**CONDUCTOR SCREEN**	ohm - cm	
	Material		Extruded Non-Metallic Semi Conducting Compound
	Thickness (Min)		0.3
4	**INSULATION**		
	Material		Extruded, XLPE as per IS: 7098 Part-2
	Thickness (Nom.)	mm	8.8
	Volume Resistivity		
			1 x 10^14
5			1x 10^12
	at 27 deg C		
	at 90 deg C		90 Deg .C.
6	**CONDUCTOR TEMPERATURE**		250 Deg. C.
7			
8	Rated		Extruded Non-Metallic Semi Conducting Compound
	During short circuit	mm	0.3
	INSULATION SCREEN		
	Material		0.04 mm Copper Tape
	Thickness (Nom)	mm	Red, Yellow & Blue Stripes Below Copper Tape
	METALLIC SHIELD		
	Material & Thickness		

S.No.	Description	cores x sq.mm	3 C x 400
9	**CORE IDENTIFICATION**	ohm/km	Extruded PVC Type ST-2 as per IS:5831
	INNER SHEATH	ohm/km	0.7
	Material		Black
10	Thickness (Min.)	Amps	
	Colour	Amps	Galvanised Steel Flat Strip as per IS:3975
	ARMOUR	µF/km	4 x 0.8
	Material	Ohm/km	
11	Thickness(Nom)		Extruded, PVC Type ST-2 as per IS: 5831
	OUTER SHEATH		3.00
	Material		Black
12	Thickness (Min.)		
	Colour		0.0778
	ELECTRICAL DATA		0.1000
	Max.D.C. resistance at 20deg.c.		
	A.C. resistance at		395
	90 deg C **Current**		530
	rating in ground at		0.250
	30 deg C in air at		0.0971
	40 deg C		
	Approx. capacitance		
	Approx reactance at 50 Hz		
	Short circuit current rating	KA	37.60
	Impulse voltage withstand capacity		170 KV
		mm	103.0
	CABLE DATA		+/- 3mm
13	Approximate overall dia of cable		CABLE ELECRTIC, Voltage Grade, CABLE SIZE, YEAR OF MFR.
	Tolerance on overall dia		15 x D mm
	Printing / Embossing		250 mtrs
	Min. Bending radius		+/- 5
	Drum Length (Non-returnable	shall be provi	+/- 5
14	wooden drum)	one mtr	
	Drum Tolerance (%)		
	Overall Tolerance (%)		
15	Sequential length marking		

Cables are conforming to IS: 7098(Part - 2)2011

TECHNICAL DATA SHEET

DATA SHEETS FOR LT XLPE 3.5C ALUMINIUM ARMOURED CABLES

S No	Description	cores x sq.mm	3.5 C x 240 to 400
1	**GENERAL**		
			A2XFY

	Voltage Grade		650/1100 volts
	Standards Applicable		IS: 7098 (Part I) 1988, IS:5831-1984, IS:8130-1984, IS:3975
2	**CONDUCTOR**		
	Material		Stranded Compacted Setor shaped Aluminium conductor as per Class-2 of IS:8130-1984
	Cross Sectional Area (M/N)	sq.mm.	240/120
	Max.C.R.@ 20°c.(M/N)	ohms/km	0.125/0.253
3	**INSULATION**		
	Material		Extruded Cross-linked polyethylene (XLPE) as per IS:7098 Part-1
	Thickness (Nom.)	mm	1.7/1.2
	Volume Resistivity	ohms-cm	
	at 27 deg.c.		1 x 10^14
	at 90 deg.c.		1x 10^12
	CONDUCTOR TEMPERATURE		
	Rated		90 Deg .C.
	During short circuit		250 Deg. C.
4	**INNER SHEATH**		
	Material		Extruded PVC Type ST-2 as per IS: 5831-1984
	Thickness (Min.)	mm	0.60
	Calculate dia over laid up cores	mm	46.90
	Colour		Black
5	**ARMOUR**		
	Material		Galvanised steel Flat Strip as per IS: 3975
	Size	mm	4 x 0.80
	Calculated dia under armour	mm	48.10
6	**OUTER SHEATH**		
	Material		Extruded PVC Type ST-2 as per IS: 5831-1984
	Thickness (Min.)	mm	2.04
	Colour		Black
	Approx.overall dia of cable	mm	51.70
	Tolerance on overall dia		+/- 3mm
7	**ELECTRICAL DATA**		
	Max DC resistance at 20 deg C	Ohm /Km	0.1250
	AC Resistance at 90 deg C	Ohm/km	0.1600
	Capacitance	µF/Km	0.63
	Reactance at 50Hz	Ohm/Km	0.072
8	**Current Ratings**		
	In ground at 30 deg C	Amps	327
	In air at 40 deg C	Amps	392
	Short circuit rating for 1 second	KA	22.6
9	**Cable Data**		
	Drum Length (Non-Returnable Wooden Drum)	meters	500

	Drum Tolerance (%)		+/- 5
	Overall Quantity Tolerance (%)		+/- 5
	Core indentification		3.5 Cores - Red,Yellow,Blue, Black
	Printing / Embossing		CABLE ELECTRIC, Voltage Grade, Cable Size ,Year Of Mfg
	Min. Bending radius		15 x D
10	Sequential Marking		Shall be provided

Cables are conforming to IS: 7098(Part-1) 1988

2.1.92. CABLE TERMINATION:

Cable terminations shall be made with aluminium crimped type solder less lugs for all aluminium cables and stud type terminals. For copper cables copper crimped solder less lugs shall be used.
Crimping shall be done with the help of hydraulically operated crimping tool.
For joints where by cable is with aluminium conductor and bus bars are aluminium, bimetallic lugs shall be used with compound. CUPAL type of washers shall be used. Crimping tool shall be used for crimping any size of cable.

2.1.93. CABLE GLANDS:

Cable glands shall be of brass single compression type. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations.

2.1.94. FERRULES:

Ferrules shall be of self-sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

2.1.95. CABLE JOINTS:

Kit type joint shall be done and filled with insulating compound. The joint should be for 1.1 KV grade insulation.

2.1.96. CABLE LAYING

The scope consists of Design, manufacture, shop testing, supply at site, storage, cable trays, cable supporting angles, and accessories for trays, cable supporting angles, and accessories for cable erection such as glands, lugs, Hume pipes etc. tray covers, cable route markers for buried cable trench, including all accessories, fittings and sundry materials to make the job complete.

The scope includes supply of Perforated type cable trays for control room cables including all accessories, fittings and supports. Successful we of this contract shall be responsible for any loss or damage or additional cost for completion of control room.

This section covers laying of cables, in cable trenches cable jointing, termination at both ends and testing of the complete cable installation. The trench shall be leveled to the formation

level of the yard. The cable route is shall be marked at regular intervals of 10 M by providing cable route marking pegs.

Cable schedules and drawing indicating the cable routing shall be furnished by the for approval. The cable laying shall be done strictly as per approved schedules.

Cable lugs shall be provided by the we for cables. We shall supply all other cable terminating accessories, like jointing ferrules, cable clamps, cable grips, cable compound flux, tapes, etc., as necessary and shall include supply of such accessories in the quoted rates. Dressing/bunching of all individual cores of the cables shall be done in a neat fashion. The we shall drill holes suitable for the cables in cable gland plate.

Cable lugs shall be compressed on the conductor ends by means of tools. Insulating sleeves shall be furnished and covered over the bare ends of the connections so as to prevent accidental contact with the ground or with the adjacent terminals.

The insulating sleeve shall be fire resistant, and long enough to over pass the conductor insulation and shall be of correct size of the conductor used.

Cable entering the control room from out door areas shall be sealed.

Standard cable grips and seals shall be utilized for cable pulling after pulling cable, the we shall put and attach aluminum cable markers at both ends of the cables and at the control room entry. The cable number and other data shall be punched and the cable markers are shall be securely attached to the cables.

Cable shall not be jointed and used for laying purpose. When necessary the approval of the Engineer at site should be taken before resorting at jointing.

Sharp bending cables shall be avoided. Cables shall cross control room basement wall in 4" A.C. Pipe embedded in cement concrete in basement wall. These pipes shall be supplied and installed by we.In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints shall be made.
The bidder shall put sufficient lengths of each cable to permit neat arrangement of all cables.

Cable splices shall not be permitted except where called for or where permitted by the purchaser.

At cable terminal points where the conductor and cable insulation shall be terminated, termination shall be made in a neat, workman like and approved manner by men specialized in this class of work.
Before any cable terminal connections are made, conductor's insulation shall be pulled out, at the end and identifying ferrules shall be fixed according to the wiring diagrams. Connection shall be made according to the wiring diagram
Polarity, or phasing shall be checked before connections are made and the we without additional cost shall make corrections of polarity, phasing or rotation.

Control cable terminations shall be made in accordance with wiring diagram using color codes established by the purchaser for the various control circuits, by code marked wiring diagrams furnished to the we for this purpose or any other approved means of identification. It is the intent that the we shall terminate the cable where the contractor lays.

Additional work of testing and reconnecting where leads have been brought to the terminal boards and connected, but where on further testing, reversed or other rearrangement of load turns out shall be necessary shall be performed by the we without additional cost.

Jointing of cables shall be in accordance with Indian Standard codes. The we shall arrange the manufacturers special instructions on materials and tools required for cable jointing work. Metal sheath and armour of the cable shall be connected to the Earthing system of the station by a steel strip wire. The we shall furnish two sets of marked up cable layout drawings after installation, indicating altered cable routes and location of straight joints.

Cable from equipment to trench shall run in GI conduits. Necessary conduits of adequate sizes and length shall be supplied and installed by the we. Flexible conduit should be used between fixed conduit/cable trays (perforated type) and equipment terminal boxes, where vibration is anticipated. The flexible conduit shall be as per relevant IS.

11.12 POST INSTALLATION CHECKS ON CABLE TRAYS:

The following shall be checked before laying the cables on the trays:-

1. Check for proper painting and identification numbers of cable trays.
2. Check for continuity of power and control cable trays over the entire route.
3. Check that oil, sharp washers, bars and waste material have been removed from the trays. Check for earth continuity and earth connection of cable trays.

INTERNAL WIRING

Providing fixing and layout of electrical system unit including fixtures, wiring, cabling conduting fixing & connecting to the mains panel distribution boards, power points, light points and earthing system. The work to be carried out as per electricity safety rules and practices materials used shall be ISI approved only.

2.1.97. TECHNICAL SPECIFICATIONS

- **GENERAL SCOPE OF WORK**

The electrical scope of work covers the followings:
a. Internal electrification through concealed/surface PVC conduit and provide light points and socket outlets as shown in the detailed drawings.
b. Provide telephone outlets as shown in the detailed drawings.
c. Provide Distribution panel at convenient locations to facilitate power for lights, fans, sockets, power plugs data points through UPS supply. UPS supply shall be separate..
d. Provide Power distribution network including Panels, cabling, mains and sub-main wiring.
e. Scope of work shall include supply installation, testing and commissioning of complete

electrical installation
f. Earthing of electrical installations complete in all aspects.

2.1.98. REGULATIONS AND STANDARDS

The installation shall conform in all respects to Indian Standard Code of Practice for Electrical wiring installation IS:732-1963 and IS:2274-1963. It shall also be in conformity with Indian Electricity Rules and the Regulations, National Electric Code and National Building Code. CPWD specifications and requirements of the Local Electric Supply Authority. In general, all materials, equipment and workmanship shall conform to the Indian Standards, specifications and code. Some of the applicable codes/standards are as under:

The following standards and rules shall be applicable:

IS: 1646 Code of practice for fire safety of buildings (General) Electrical installation

IS: 4648 Guide for electrical layout in residential building Indian electricity act and rules.

IS 375 – 1963 Marking and arrangements for switchgear: Bus bars, main connection and auxiliary
wiring.
IS 2675 – 1983 Specifications for enclosed distribution

IS10118-1982 Installation and maintenance of switchgear.

IS 1554 – 1988 Specifications for PVC insulated (heavy duty) electric cable Part-I for voltage up to 1100 volts.
IS 694-1990 Specifications for PVC insulated: Cables for voltage up to 1100V with Aluminium conductors.

IS 9537 – 1981 Specifications for Rigid Steel conduit for electrical wiring.

IS 3837-1976 Specifications for accessories for rigid steel conduits for electrical wiring.

IS 5133 – 1969(Part-I) Boxes for the enclosure of electrical accessories, Steel and CI boxes.

IS 1293 – 1988 3 pin plugs and socket outlets

IS 1913 – 1978 General and safety requirements for electric lighting fittings.

IS 374 – 1979 Electric ceiling fans and regulators.

IS 3043 – 1987 Code of practice for earthing

IS 1646 – 1982 electrical installation.

IS 2705 – 1992 Current transformers

IS 1248 – 1983 Direct acting electrical indicating instruments.

IS 8623 Factory built assemblies of switch gear & control gear.

IS 8828 MCB

IS 2516 MCCB

IS 13947 SFU

IS 12640 ELCB

2.1.99. INTERNAL ELECTRIFICATION OF BUILDING

SCOPE

Under this head, the bidder is to carry out the internal electrification of the auditorium as mentioned under para 1.0.

The scope covered under this head includes concealed/surface conduiting, wiring, provision of distribution boards, submains/mains and fittings.

- **GENERAL**

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1989 and IS: 2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these becomes applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications with up to date amendment.

General Specifications for Electrical Works. (Part I - Internal) – 1994.
Wherever this specification calls for a higher standard of material and or workmanship than those required by any of the above mentioned regulations and specification then the specification here under shall take precedence over the said regulations and standards.

2.1.100. DISTRIBUTION BOARDS

Distribution Board shall be standard type as per the CPWD specifications. All distribution boards shall be of three phase (415 Volts) or single phase (240 volts) type with incoming isolator or MCB as in Schedule of quantities. Distribution boards shall contain plug in or bolted type miniature circuit breaker mounted on busbars. Miniature circuit breakers shall be quick make and quick break type with trip free mechanism. MCB shall have thermal and magnetic short circuit protection. MCB shall conform with IS 8828-1978. Neutral busbars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and

adequate space for all incomingand outgoing cables. All distribution board enclosures shall have an etched zinc base stove painted followed by synthetic stoved enamel, colour light gray.

A circuit identification card in clear plastic cover shall be provided for each distribution board. Miniature Circuit Breakers for lighting circuits shall be of "L" series where as `G' series MCB's shall be invariably used for motor loads, halogen lamps fitting, sodium/mercury discharge lamps and for all power circuits. All miniature circuit breakers shall be of 9 KA rated rupturing capacity.

2.1.101. SURFACE CONDUIT

Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other approved plugs with screws in an approved manner at an interval of not more than one meter but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30cm from the center of such fittings. The saddles should not be less than 24 gauge for conduits upto 25 mm dia and not less than 20 gauge for larger diameter conduits. The corresponding widths shall be 19 mm & 25 mm. Where conduit pipes are to be laid along the trusses, steel joint etc. the same shall be secured by means of special clamps made of MS. Whereas it is not possible to drill holes in the trusses members suitable clamps with bolts and nuts shall be used.

For 25 mm diameter conduit width of clip shall be 19mm and of 20 SWG. For conduit of 32 mm and above, width of clip shall be 25mm and of 18 SWG.
Where conduit pipes are to be laid above false ceiling, either conduit pipes shall be clamp to false ceiling frame work or suspended with suitable supports from the ceiling slab. For conduit pipe run along with wall, the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with special clamps if required to be approved by the Engineer-In-Charge at site.

2.1.102. RECESS/CONCEALED CONDUIT

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 building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. Incase of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work. Entire work of chasing the wall, fixing the conduit in chases, and burring the conduit in mortor before plastering shall form part of point wiring work.

The conduit pipe shall be fixed by means of staples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius which shall permit easy drawing in of conductors. Suitable

inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and of facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 meters, then circular junction box shall be provided.

2.1.103. OUTLET BOXES & COVERS

The switch box shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanised mild steel. Upto 20 x 30 cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30 cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All fitting shall be fitted in flush pattern. Phenolic laminated sheet of approved shade shall be used for switch box covers.
These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

2.1.104. ERECTION AND EARTHING OF CONDUITS.

The conduit if used metallic of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit. Gas, water pipe shall not be used as earth medium.

2.1.105. SWITCHES.

All 5 and 15 Amp switches shall be piano type of 240 volts A.C. grade. All switches shall be fixed on 3 mm thick laminated sheet cover. All 5 Amp socket shall be 5 pin type. All 15 Amp socket shall be 6 pin type suitable for 15/5 Amp. All switches, sockets, telephone outlets, etc. shall be in off white finish. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switches shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings. In dean, professor and lecturers rooms switches and socket outlets shall be modular type in modular metal box.

2.1.106. FLUSH COVER PLATE.

All switches, sockets, telephone outlets etc. shall be fixed on 3 mm thick phenolic laminated sheet cover. Flush cover plate shall be secured to the box with counter sunk brass screws & cup washers.

2.1.107. WALL SOCKET PLATE.

All 5 and 15 Amp socket outlet shall be 5 and 6 pin respectively. Each outlet shall have a switch located beside the socket preferably on the same flush cover plate. The earth terminal of the socket shall be connected to the earth wire.

2.1.108. WIRING

All PVC insulated stranded copper conductor wires shall conform to relevant IS Codes.

All internal wiring shall be carried out with PVC insulated FRLS wires of 650/1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switch board may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switch boards.

A separate earth wire shall be provided alongwith circuit wiring for each circuit. For point wiring red colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated wire for RYB phase wire respectively and black colour PVC insulated wire for the neutral wires. Bare copper wire shall be used as earth continuity conductor and shall be drawn alongwith other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed.

Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing and jointing of copper conductor wires and cables shall be as per CPWD specifications.
Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS: 694 – 1990

- **JOINTS.**

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet.

- **MAINS AND SUBMAINS.**

Mains and sub-main cable where called for shall be of the rated capacity and approved make. Every main and sub-main shall bedrawn into an independent adequate size conduit. Adequate size draw boxes shall be provided at convenient locations to facilitate easy drawings of the sub-main & main cables. Cost of junction box/drawn box is deemed to be included in the rates of sub main wiring. As independent earth wire of proper rating shall be provided for

Nominal Sectional area of conductor in Sq.mm.	25mm		32mm		38mm		51mm		64mm	Cross-
	S	B	S	B	S	B	S	B	S	B
1	4	5	6	7	8	9	10	11	12	13
1.5	10	8	18	12	-	-	-	-	-	-
2.5	8	6	12	10	-	-	-	-	-	-
4	6	5	10	8	-	-	-	-	-	-
6	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	-	-	-	-
16	2	2	3	3	6	5	10	7	12	8
25	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	3	2	6	5	8	6
50	5	-	-	-	-	-	-	5	3	6
70	-	-	-	-	-	-	4	3	5	4

every sub-main. Single phase sub main shall have single earth wire whereas three phase sub main shall be provided with two earth wire. The earth wire of proper rating shall be fixed to conduits by means of suitable M.S. clips at not more than 1000 mm distance. Where mains and sub-mains cables are connected to the switchgear, sufficient extra lengths of sub main and mains cable shall be provided to facilitate easy connections and maintenance. For termination of cables creeping type cable socket/lugs shall be provided. Same color code as for circuit wiring shall be followed.

NOTE:

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed `S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more

than 15 degrees. The columns headed `B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
3. Conduit sizes are the nominal external diameters.

- **LOAD BALANCING**

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

- **COLOUR CODE FOR CIRCUIT & SUBMAIN WIRING.**

Colour code for circuit and submain wiring installation shall be Red, Yellow, Blue for three phases. Black for neutral and yellow/green or green only for earth incase of insulated earth wire.

2.1.109. CLASSIFICATION OF POINTS.

- **General**

Classification and measurement of Point wiring shall be as per CPWD specification for Electrical Works (Part-I-Internal)1994.

- **CONDUCTOR SIZE.**

Wiring shall be carried out with following sizes of PVC insulated stranded single core copper conductor wire/cable.
i. Light point. - 1.5Sq.mm
ii. Ceiling /Cabin/Exhaust Fan Point - 1.5Sq.mm
iii. Call Bell Point - 1.5Sq.mm
iv. Plug Point (5 A S.S. outlet) - 1.5Sq.mm
v. Circuit Wiring - 2.5Sq.mm
vi. General Power Point – 4Sq.mm

2.1.110. LIGHTING FIXTURE AND FANS

- **GENERAL**

a) The Contractor shall supply and install lighting fixtures including but not limited to lamps, ballasts, accessories fixing hardware necessary for installations, as shown on the Drawings, as required, and as herein specified.
b) All fixtures shall be delivered to the building complete with suspension accessories, canopies, hanging devices, sockets, holders, reflectors, ballasts, diffusing material, louvers, plaster frames, recessing boxes, etc. all wired and assembled as indicated.
c) Full size shop detail drawings of special fixture or lighting equipment, where called for in the fixtures schedule, shall be submitted to the Engineer in-charge for approval.
d) Fixtures, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.
e) Fixtures shall comply with all applicable requirements as herein outlined
f) Manufacturer's name and catalogue number of lighting fixtures are given for general reference only. It shall be understood that the actual fixtures supplied shall meet all the

requirements of the specification, and, if necessary, the standard fixture indicated for reference, shall be modified accordingly.

g) Fixtures shall bear manufacturer's name and the factory inspection label.
h) Fixtures shall be completely wired and constructed to comply with the IEE wiring regulations requirements for lighting fixtures, unless otherwise specified.
i) Revamping the fixture shall be possible without having to remove the fixture from its place.
j) Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixtures.

- **WIRING WITHIN THE FIXTURES**

a) Fluorescent fixtures shall be wired with not smaller than 1.5 sq. mm asbestos-covered wire. No splice or tap shall be located within an arm, stem or chain. Wire shall be continuous from splice in outlet box of the building wiring system to lamp socket or to ballast terminals.
b) Wiring within incandescent fixtures and for connection to the branch circuit wiring up to the outlet box of lighting point shall not be less than 1.5 sq. mm silicone rubber insulated wire. (150oC temperature).

- **INSTALLATION**

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer-In-charge.

Pendent fixtures within the same room or area, shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within the fixture and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

2.1.111. ENERGY EFFICIENT LED BASED LUMINAIRE UNIT FOR INDOOR & OUTDOOR LIGHTS

- **SCOPE**

The scope of work includes design, development, manufacturing, testing, supply, installation and commissioning of energy efficient luminiar complete with all accessories, LED lamps with suitable current control driver circuit including mounting arrangement for recessed type & ceiling mounting arrangements. The luminiar shall be suitable for rugged service under the operational and environmental conditions encountered during service. The following types of luminaries are required to be provided:

1. LED Tube Light/ LED Line fitting
2. LED Bulb

Sl No	Place/Location	Type of lighting Fixture	Lighting level
1	Main control room	LED	300 lux
2	Other areas inside The pump house	-Do-	100 lux
3	Machine hall (high bay)	LED	250 lux
4	Transformer bay	LED	200 lux
5	Switch yard and other approach Roads	LED	150 lux

Each type of luminarie shall be supplied with associated driver circuit compatible with LEDs in all respect as required including complete optics.

- **SERVICE CONDITIONS:**

Indoor lights on pipe/Recess mounting type light unit complete with luminaries and mounting

accessories shall be suitable for Buildings(indoor) of pump hous under the following environmental conditions: -

Environmental conditions

Maximum ambient air temperature: 45□ C

Minimum ambient air temperature: -5□ C

Max. Relative humidity 100%

Atmosphere Extremely dusty and desert weather and desert terrain in certain areas. The dust contents in air may reach as high values as 1.6 mg/m3

Coastal area: The equipment shall be designed to work in coastal area in humid, salt laden and corrosive atmosphere.

- **REFERRED STANDARDS**

IS: 513 Cold-rolled low carbon steel sheets and strips

IEC 60529 Classification of degree of protections provided by enclosures.

EN 55015, CISPR15 Limits and methods of measurement of radio disturbance characteristic of electrical lighting and similar equipment

IEC 62031 LED modules for general lighting-Safety requirements

EN 61547 Equipment for general lighting purposes – EMC iimunity requirement.

EN 60929 Performance, AC supplied electronics ballast for tubular fluorescent lamps performance requirement.

IEC 60598-2-1 Fixed general-purpose luminaries

IEC 60598-1 Luminaires - General requirement and tests

IEC 61000-3-2 Electro Magnetic compatibility (EMC) -Limits for Harmonic current emission -– (equipment input current ≤ 16 Amps. per phase.

IEC 60068-2-38 Environmental Testing: Test Z- AD: composite temperature/ humidity cyclic test

IEC 61347-2-13 Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules

IS 10322 Specification for the luminaries

IS 4905 Method for random sampling

LM 79 LED luminaire photometry measurement

LM 80 Lumen Maintenance

IEC 62384 DC or AC supplied electronic control gear for LED modules performance requirements

IEC/PAS 62612 Self-ballasted LED lamps for general lighting services- Performance requirements

- **CONSTRUCTION**

a. All the luminiars shall be finalized based on the performance feedback. The detailed calculation for lux level as per clause no.5.8 with uniform distribution including the lux distribution curve /graph distribution shall be submitted in support of the dimensions selected and variation thereof. Housing, if not used as a heat sink shall be made of at least 0.8 mm thick sheet Steel conforming to IS: 513 (Grade O)/CRCA polyester powder coated of at least 60 microns) and high U.V. & corrosion resistance. Heat sink used should be aluminum extrusion having high conductivity preferably to grade 6061 alloy or better having thermal conductivity of at least 170-180 W/m.K or Aluminium die cast having high conductivity preferably ADC 12 or LM 24. Efforts shall be made to keep the overall outer dimensions as minimum as possible.

All luminaires shall be provided with toughened glass of min. 0.8 mm thickness of sufficient strength and high efficiency (90%) prismatic diffuser under the LED chamber to protect the LED and luminaries. And shall not show yellowness during luminarie life time.

1.Tube Light /Line fitting
2. LED Bulb

Suitable number of LED lamps shall be used in the luminiars. LED lamps of Reputed make shall be used for the purpose. The manufacturer shall submit the proof of procurement of LEDs from above OEMs at the time of testing. Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution. Supplier will be solely responsible for testing and performance of the luminaries after installation

and shall also ensure the specified and uniform illumination and comfort level on the work desk/ floor. Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

High power and high lumen efficient LEDs suitable for following features shall be used:

- The efficiency of the LED lamps at 85 Deg C junction temperature shall be more than 85%.
- The working life of the lamp at junction temperature of 85 Deg C at rated current shall be more than 50,000 working hours of accumulative operation and shall be suitable for continuous operation of 24 hours per day. These features shall be supported with datasheet.
- Adequate heat sink with proper thermal management shall be provided.
- Colour temperature of the proposed white colour LED shall be 5700k (nomonal CCT) and the color variation should be 5665 +/-365K (ANSI binning)
- Minimum view angle of the LED shall not be less than 1200.
- The output of LED shall be more than 100 lumen per watt at minimal operating current and shall ensure guaranteed operation life of 50,000 burning hours with controlled junction temperature of 850C.
- Lumen maintenance report as per LM 80 guidelines shall be produced for the power LEDs
  used.

Power factor of complete fitting shall be more than 0.9 at full load 240V. Thermal management shall be in such a way that LED soldering point temperature shall not go beyond 75 degree centigrade. Input frequency range shall be between 50Hz±3%.
The LED luminaire shall be free of glare.
Color rendering index CRI >=75

LED DRIVER specification used for street light

- Input voltage Range within 180Vrms to 270Vrms
- Operating input voltage 240Vrms
- No load power consumption ≤ 500mW
- Output voltage 105VDC±3%
- Output voltage ripple should be within 3%
- Output over voltage protection 125VDC
- Power factor 0.95
- Full Load Efficiency ≥ 90%
- THD ≤8 %
- Hot swapping
- Load regulation ±5%
- Current waveform should meet EN 61000-3-2
- Led Driver shall withstand, withstand voltage of 440V for 2 hours and restore normal working
- when normal voltage is applied
- Maximum Temperature rise <= 30ºC @ 45ºC Tamb with safety margin of 10oC
- The driver should comply to CISPR 15 for limits and methods of measurement of Radio

- Disturbance characteristics
- The equipment should comly
- The controlgear should be compliant to IEC 61347-2-13, IEC 62031 and IEC 62384 as per the
- requirements
- The equipment should be compliant to IEC 60598-1, IEC 62031and IEC/PAS 62612 depending on
- the type of luminaire.

TECHNICAL REQUIREMENTS

The driver of the luminiars should have

- 2 x 2 Fixture- Shall have Short Circuit, Over Voltage, String Open protections.
- 1 x 1 Fixture- Shall have Short Circuit, Over Voltage, String Open protections.
- Tube Light – Shall have Over Circuit, Over Voltage protections.

The electronic components used shall be as follows: -

- IC (Integrated circuit) shall be of industrial grade or above.
- Metallic film / Paper/Polyester Capacitor shall be rated for a temperature of at least 105ºC.
- The resistors shall be preferably made of metal film of adequate rating. The actual loading versus rating shall be 3.
- The junction temperature of the Switching devices such as transistors and MOSFETs etc. shall not exceed 125ºC (allowing thermal margin of 25 ºC).
- The conformal coating used on PCBs must be cleared and transparent and shall not affect colour code of electronic components or the product code of the company. The LED must be mounted on MCPCB, which should be made up of Metal core (Aluminum metal core) and should have the alumina coating with aerosol spray process of manufacturing to have the better heat conduction or dissipation.
- MCPCB shall be made with OPA dielectric thickness of 0.1mm and Al 5052H34. MCPCB must comply with IPC-A-600G and IPC-6012A class 2. UL approved solder mask and silkscreen must be used.
- The heat sink compound used should be of silicon with high thermal conductivity with 3W/mk.
- The heavy components shall be properly fixed. The solder connection shall be with good finish.
- The electronics covered for this equipment shall pass all the tests called for in the specification
- The infrastructure for Quality Assurance facilities as called for in the specification shall be available for the manufacturing of this product.

The connecting wires used inside the luminiar, shall be low smoke halogen free, fire retardant PTFE

cable and fuse protection shall be provided in input side. Care shall be taken in the design that there is no water stagnation anywhere. The entire housing shall be dust and water proof having IP20 protection as per IEC 60529.

The control gear shall be designed in such a way so that temperature rise of MCPCB shall not be more than 200C with respect to ambient temperature when measured half inch away from the component. Luminiar shall be such that the glare from individual LED is restricted and

shall not cause inconvenience to the people. The Diffuser should be used in the luminiar to restrict the glare of LEDs. And should have no yellowness during the entire life of the luminaire.

All the material used in the luminiar shall be halogen free and fire retardant confirming to UL94 V.0

Illumination Level: The fitting shall be so designed that the illumination level shall be evenly distributed and shall be free from glare. Illumination level of different types of luminiar shall be as below:

Sl. No.	Place to be illuminated	Vertical Distance of fittings from the floor level(Mtrs)	Average Illumination Level (Lux)	Colour Temp in oK
Indoor Light				
1	Work areas	2.743	250 at 1mtr above ground level	5500 to 7000
2	Corridors	2.743	125 on the floor	5500 to 7000

* Illuminance at center is assumed for single luminaire.

Note:

1. Variation in illumination level shall be ±2% is allowed in input voltage range from 180VAC to 270VAC.
2. The illumination shall not have infra-red and ultra-violet emission. The test certificate from the NABL approved laboratory shall be submitted

TESTS:

Tests are classified as:

Type test

Acceptance test

Routine rest.

Type Test

Type tests shall be carried out to prove confirmation with the requirement of specification and general quality/design features of the unit. In case of any change in Bill of Material or design of unit, complete type test shall be repeated. If any sample fails in any of the type tests, two fresh samples shall be taken and tested. If any sample again fails in that test, the whole lot shall be rejected.

Acceptance Tests:

These tests are carried out by an inspecting authority at the supplier’s premises on sample taken from a lot for the purpose of acceptance of a lot. Acceptance tests shall not be carried out from particular size from the lot on which type tests have already been conducted. Recommended sampling plan is given below.

Sample size and criteria for conformity

The luminaries shall be selected from the lot at random. In order to ensure randomness of selection, procedures given in IS 4905-1968 (Reaffirmed 2001) may be followed.

Routine Tests:

These tests shall be performed by the manufacturer on each complete unit of the same type and the results shall be submitted to the inspecting agency, prior to offering the lot for acceptance test. the
firm shall maintain the records with traceability.

Method of Testing

Visual and Dimensional Check:

The unit shall be checked visually for all dimensions as per approved design and drawing. General workmanship should be good; all the components properly secured and sharp edges shall be rounded off. Check the marking and quality of the workmanship visually. Check the rating and make of electronic / electrical items.

Checking of documents of purchase of LED

Check Document of purchase of LED lamps of approved sources viz. NICHIA/ OSRAM/ SEOUL/ PHILIPS LUMILEDS / LEDNIUM/AVAGO/CREE.

Resistance to humidity test

This is carried out by suspending the painted panels in corrosion chamber maintained at 100% RH and temperature cycle of 42 to 48 deg. C for 7 days and examining it for any sign of deterioration and corrosion of metal surface.

Insulation resistance test

The insulation resistance of the unit between earth and current carrying parts shorted together shall not be less than 2 M□ when measured with 500V megger.

HV test

Immediately after insulation resistance test, an AC voltage of 1.72 KV rms (1500 + 2 x rated voltage) of sine wave form of 50 Hz shall be applied for one minute between the live parts and frame. There shall not be any kind of break down, flashover or tripping of supply.

Over voltage protection

The Luminaire shall withstand at 300V AC for two minutes.

Surge protection

It shall withstand a surge of 1.5kV „b 3% for 50 microseconds „b 20 % at the input terminals for all types. (Tests shall comply with Clause 5.4 of latest IEC 60571-1).

Reverse polarity

The Luminaire shall withstand polarity reversal. It shall be operated with reverse voltage for 5 minutes at maximum value of voltage range. At the end of this period, the supply shall be made correct polarity and Luminaire shall operate in a normal way.

Temperature rise Test:

Temperature rise Test shall be conducted at 100VAC with full load. The temperature rise shall be recorded by temperature detectors mounted at the specified reference points on the body of

semiconductors, capacitors and other components as agreed between purchaser and manufacturer. The maximum-recorded temperature under worst conditions shall be corrected to 550C and compared with maximum permissible temperature (for power devices at junction). Under loading conditions as specified above, the corrected temperature of the power devices shall have a safety margin of minimum 100 C. Temperature at junction shall not exceed 100 0 C when corrected to 550 C. The Luminiar shall also be subjected for short time rating after continuous loading to ensure the temperature rise is within the permissible limit. The maximum temperature rise of the electronics devices on the PCBs shall be in limit for industrial grade components suitable for 850C environment. In case of exceeding limit, use of MIL-grade component shall be considered keeping RDSO informed.

Ra (Colour Rendering Index) measurement test

- The lumen is the unit of luminous flux, which is equal to the flux emitted in a solid angle of
- one Steradian by a uniform point source of one candela.
- The initial reading of the chromaticity co-ordinates x & y shall be within 5 SDCM (Standards
- Deviation for Colour matching) from the standardised rated value as per Annex. D of IEC
- 60081 – 1997.
- The initial reading of the general colour-rendering index (Ra) shall not be less than the rated
- value decreased by 3.
- The lumen maintenance of the lamp shall not be less than 80% of the initial lumen after
- 20000 burning hours and 70% of the initial lumen after 50000 hours . The initial lumen will be
- taken after 100 hours aging
- Photometric test shall be conducted as per Annexure B of IEC 60081-97.
- The lumen maintenance test shall be done as per Annexure C of IEC 60081-97.

Lux measurement

Lux measurement with the help of Lux meter shall be done at a distance. Value obtained shall not be less than the Lux specified in the table considering 10% Lumen is absorbed by the reflector.

Fire retardant Test

Fire Retardant test shall be conducted as per IEC 60332-1 of the wire used in the fittings.

Test for IP20 protection

This test shall be conducted as per IEC 60529.

Environmental tests

The Luminiar shall meet the following tests as prescribed in IEC – 60571.

a) Dry heat test.

b) Damp heat test

c) Test in corrosive atmosphere

d) Combined dust, humidity and heat test

Reliability Test

The reliability can only be determined in actual service. However, the following tests shall be carried out on the prototype to simulate as close as possible, the service conditions. There shall be no failure during this test.

a) The light unit shall be mounted in an oven maintained at 45°C.

b) The light will be operated at the specified maximum voltage and at 45°C for a period of 100 hours.

Life Test

The lumen maintenance & life test shall be done as per Annexure C of LM 80 Report of LEDs.

Endurance Test

The Luminiar shall be kept "ON" with input voltage of 250VAC for 200 hours. After this the Luminiar is subjected to 20,000 cycles of "ON" and "OFF", each cycle consisting of 3 seconds "ON" and 10 seconds "OFF" period. Luminiar should survive this test. Test is to be continued for 20,000 cycles, followed by performance test.

Safety:

The Luminaire shall comply with the safety requirements as per IEC 61195.

MARKING:

The following information shall be distinctly and indelibly marked on the housing:

a) Year of manufacture/Batch Number/ Serial Number

b) Name of Manufacturer

c) Rated watt and voltage

d) Input frequency

APPROVAL

The manufacturer shall also submit details like make, type, reliability grade, rating and loading of
various electronic components used in the circuit. The temperature rise of the various components
under the most adverse conditions shall also be declared.

- Technical specification for LED STREET LIGHT & FLOOD LIGHT of – 80 Watts
- Input voltage: 90 V to 270 V
- LED lamp efficacy: Min 95 to 130 lumens/watt
- Power factor: >0.90
- Life expecting: 50,000 hours
- No of hours usage / day: 10 to 12 hours/day
- Rated watt: 80 W (cool white)
- Luminous flux: 7500 to 10500 lumens
- LED type: High power LED (1 Watt)
- Working Humidity: 10% to 90%
- Colour Temperature: 4,500 to 7,000 K with test certificate

- Ingress protection: IP 65/IP 66 as per IS/IEC60529-2001 with test certificate.
- Total harmonic distortion (THD): <15% with test certificate
- Colour rendering index: Ra > 80
- Working Temperature: 20 deg to 50 deg C
- Average lighting/ beam angle: 120 to 160 deg
- Control Circuit: Compatible to LED
- Lamp starting time: Not more than 5 sec
- Energy consumption: Not more than 1.2 times at rated voltage
- System power efficiency: > 85 %
- Luminary Casing: Pressure die cast Aluminum with toughened glass cover and water proof fixture.

LED thermal management: LED shall be mounted on heat sink conductive aluminum with fins to dissipate the heat to ambient air

Driver board: Details shall be given for getting spare

Pole entry/ Retro fitting: Suitable for fixing in existing lighting pole (30 mm to 55 mm dia with bracket and locking bolt & nut.

Applicable Standard: IESNA LM 79 for fixture and with stand to wind velocity 150 mph with test certificate

Electrical connector: Connecting wires with minimum one-meter length

Warranty: 2 Years

2.1.112. CEILING FANS

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/roof members. Contractor to ensure that provision are kept at appropriate stage at locations shown on the drawing. Fan box with MS hook shall be as per CPWD specification. Ceiling fan shall be double ball bearing type, copper wound motor complete with canopy, down rod, blades etc. and shall conform to relevant IS standards ceiling fan shall be white in color. Ceiling fan shall be provided with standard regulator. Regulator shall be suitable for 240 volts A.C supply 50 Hz and shall be of continuous duty type

2.1.113. EXHAUST FANS

Exhaust fans shall be heavy duty type with double ball bearing and conforming to IS 2312-1967. Exhaust fan shall be complete with copper wound motor, capacitor, Louver/shutter, frame and mounting bracket. Exhaust fan shall be suitable fan operation on 240 volts single phase A.C supply.

2.1.114. EARTHING/GROUNDING

Earthing

All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits trunking, cable amour, switchgear, distribution fuse boards, lighting fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specifications IS:3043-1966.

EARTHING CONDUCTOR

Earth continuity conductor alongwith submain wiring from Main/Sub Distribution boards to various distribution boards shall be of copper. Earth continuity conductor from distribution board onward upto outlet point shall also be of bare copper. Earth continuity conductor connecting Main & Sub Distribution boards to earth electrode shall be with galvanised MS strip.

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Connection of Earthing conductors

Main earthing conductor shall be taken from the earth connections at the main distribution panel to the earth electrode with which the connection is to be made. Distribution boards, earthing conductor shall run from Main Distribution Boards. Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards. Cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commandment of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of equipment shall be earthed by means of and earthing conductor enclosed with the current carrying conductor within the flexible cord. Switches, accessories, lighting fittings etc. which are rigidly secured in effective electrical contact with a run of metallic conduit hall not be considered as a part of earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

2.1.115. LIGHTING DISTRIBUTION BOARDS

The Distribution Panel and Distribution boards shall be suitable for operation on 3 phase/single phase 415/230 Volts, 50 cycles, neutral grounded at transformer and short circuit level not less than 31 MVA at 415 Volts. The Distribution Panel/Boards shall comply with the latest addition of relevant Indian Standards and Indian Electricity Rules and Regulations.

CONSTRUCTION FEATURES

The Distribution Panels/Boards shall be metal enclosed sheet steel cubical,indoor, dead front, floor mounting/wall mounting type. The Distribution board shall be totally enclosed completely dust and vermin proof. Gaskets between all adjacent units and beneath all covers shall be used to render the joints dust proof. Distribution Boards shall be preferably arranged in multitier. All MS sheet steel used in the construction of Distribution Boards shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. All the panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with bank nuts. Self-threading screws shall not be used in the construction of Distribution boards. A base channel of 75 mm x 75 mm x 9mm thick shall be provided at the bottom. Knockout holes of appropriate size and number shall be provided in the distribution board in conformity with the location of incoming and outgoing. Removable sheet steel plates shall be provided at top and bottom to drill holes for cables entry at site if required.

BUS BAR CONNECTIONS

The bus bars and interconnections shall be electrolytic copper and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bar and shall be extensible on either side. The bus bars and interconnection shall be insulated with insulation tapes and color coded. The bus bars shall be supported on unbreakable non-hygroscopic insulated supports at regular intervals to withstand the forces arising from short circuit in the system. All bus bars shall be provided in a separate chamber and properly ventilated. All bus bar connections shall be done by clamping. No holes shall be drilled in the bus bars for mounting clamps. All connections between bus bars and switches and between switches and cable alley terminal shall be through solid copper strips of proper size to carry full rated current and insulated with insulating tapes.

FIXING OF MCB'S

All TPN Distribution Boards shall be provided with SP MCB's as outgoing. Separate neutral bus bars shall be provided for TPN distribution boards for each phase. MCB's shall be provided on the phase of each circuit. The individual banks of MCB's shall be detachable. There shall be ample space behind the banks of MCB's to accommodate all the wiring. All the internal wiring of distribution boards shall be concealed behind 5 mm thick Bakelite sheet. All the distribution boards shall be completely factory wired, ready for connections. All the terminals shall have adequate current rating and size to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

CABLE COMPARTMENTS

Cable Compartments of adequate size shall be provided in the distribution panel/boards for easy termination of all incoming and outgoing cables entering from bottom. Adequate supports shall be provided in cable compartments to support cables. All incoming and outgoing switches, terminals shall be brought out to terminal blocks in cable compartments.

INSTRUMENT ACCOMMODATION

Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contractors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of circuit breaker, bus bars and contact.

TERMINALS

The outgoing terminals of the breaker and neutral link shall be borough out to a terminal block suitably located at the rear side of the panel. Separate cable compartments shall be provided for incoming and outgoing cables.

WIRE WAYS

A horizontal wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical section.

SWITCH FUSE UNITS

The switch fuse units shall be 3 pole double break type (AC-23A) suitable for load duty quick make and break action. Separate neutral link shall be provided in the switch. All switch fuse units shall be provided with hinged doors duly interlocked with operating mechanism, so as to prevent opening of the door when the switch is in `On' position and also to prevent closing of the switch when the door is not properly secured. All contacts shall be silver plated and all live parts shall be shrouded. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS: 2208 - 1962 and having rupturing capacity of not less than 31 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to show that they have operated.

FUSES

Fuses shall be high rupturing capacity (HRC) fuse links and shall be in accordance with IS:2208-1962 and having rupturing capacity of not less than 31 MVA at 415 Volts.

PAINTING

All sheet steel shall undergo a process of degreasing, picking in acid, cold rinsing, Phosphating, pasivating and then sprayed with a high corrosive resistant primer. The primer shall be baked in an oven. The finishing treatment shall be with powder coating..

LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder switches. Circuit diagram showing the arrangement of the circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet. All the distribution boards shall be subject to tests specified in relevant Indian Standards and test certificates shall be furnished.

METERS

All the meters shall be housed in a separate compartment and accessible from front only. Lockable doors shall be provided for the metering compartments. The distribution boards

shall be provided with indicating panel comprising of 1 No.(0-500V) 90 cm x 90 mm square type voltmeter with 3 way "OFF" selector switch and CT operated ammeter with 3 way and neutral selector switch of appropriate range and scale. Wiring for motors shall be colour coded and labeled with approved plastic beads for identification.

Point Wiring (Internal & External Telephones)

The point wiring shall be carried out with Double pair telephone wire/cable, unarmoured, PVC insulated and sheath. 0.61 mm dia annealed tinned copper conductor (IS: 2532-1965)in suitable size conduit (one pair always remaining spare for one point)

Minimum Dia of Conduit for Internal/External Telephone Wiring - 20mm.

If more than one telephone point has to be provided at one point, multicore, unarmoured telephone cable shall be used (pairs required are equal to 2 No.of points)in suitable size of conduit.

The point shall commence from the main telephone tag box/sub tag box and would terminate at outlet box of point. Connection at both ends included in point wiring.

Fixing of conduit, conduit accessories draw out boxes and outlet box etc. in concealed/surface conduit works) shall be applicable for telephone wiring conduit system also.

EARTHING

(AS PER IS 3043-1987)

Earthing shall generally be carried out in accordance with the requirements of Indian Electricity Rules
2003 amended from time to time and relevant regulations under Electricity Supply Authority concerned.

In case of high and extra high voltages, the neutral points shall be earthed by not less than two separate distinct connections with earth, each having its own electrodes sub-station and will be earthed at any other point provided no interference is caused by such earthing. If necessary, the neutral may be earthed through suitable impedance. As far as possible, all earth connections should be visible for inspection. Each earthing system shall be so designed, that, the testing of individual earth electrodes is possible. It is recommended that the value of any earth system resistance shall be such as to conform to the degree of shock protection desired.

It is recommended, that a drawing showing the main earth connections and earth electrodes be prepared for each installation and submitted to Employer. No addition to the current carrying system, either temporary or permanent, shall be made which will increase the maximum available fault current on its duration until it has been ascertained that the existing arrangement of earth electrodes, earth bus-bar etc., are capable of carrying the new value of earth fault current which may be obtained by this addition.

All materials, fittings etc., used in earthing shall conform to Indian Standard Specifications, wherever
they exist.

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2.1.116. GENERAL REQUIREMENTS AND PROCEDURES FOR EARTHING

The ground resistance for sub-stations should not exceed a value 2(two) ohms. The joints/connections in the earthling, system shall be welded only, except the connections, which require opening for testing/maintenance. Such connections should be bolted tightly, using spring and ring washers for proper contact pressure.
The G.S. flats to be provided for the horizontally laid earth grid should have overlap welded joints, with length of welding at least twice the width of the flat, e.g., 100 MM for 50x6 MM G.S. flats. There should not be any dirt, grease, oil, enamel, paint or any such non-conductive coatings on the surfaces being joined/ connected. Only the finished joints/connections above ground may be provided with red-oxide or any other protective coating. Underground earth electrodes and earth grid elements, when laid, should have a clean metallic surface, free from paint, enamel, grease or any such non-conductive coatings.

As far as possible, all earth connections should be accessible for visual inspection. No cut-outs, links or switches, other than linked switches arranged to operate simultaneously on the earthed or earthed neutral conductor and the live wire shall be inserted in the supply system. Earth electrodes or mate should not be installed in close proximity to metal fence to avoid possibility of fence becoming live. Separate earth electrodes, isolated from the earth grid, are to be provided for grounding the fence wires. Pipes or rods used as electrodes should be in one piece, as far as possible, with a minimum allowable length of 3 mtrs. Except where rock or hard stratum is encountered, the pipe/rod electrodes should be driven into the ground to a minimum depth of 3 mtrs. The strip electrodes, forming the horizontal gild, should be buried underground to a minimum depth of 0.5 mtrs. The path of earth wire should be out of normal reach of any person, as far as possible.

For high resistivity soils, above 100 Ohm-mtrs., attempts should be made to bring the soil resistivity in the range of 50 to 60 Ohm-mtrs. By digging and treating the soil mass around the earth grid/electrodes
with a mixture of salt and charcoal. In case of rocky top soil and sub-stratum, having very high resistivity, with no scope of improvement by other means, the procedure given below should be followed:

- At least two bores of diameter little less than 40 mm, with a minimum distance of 10 mtrs. between them, should be made in the ground at suitable locations inside the S/S yard. The boring should be done until soil sub-stratum rich in moisture and low in resistivity is encountered. G.I. pipes of 40 MM dia. should be descended in each bore, such that, the soil mass around the pipes grips them tightly, Back – filling of bores, if required, with wet soil/clay may be done to ensure this condition. The G.I. pipes in these deep bores should be interconnected with the main earthing grid of the S/S through 50x6 mm G.S. flat, with all the joints/connections and terminations being either fully welded, or clamped/bolted and welded simultaneously. The G.I. pipes in the bores should also be interconnected with each other. In extreme cases, the bores may have to be made at remote locations i.e. outside the S/S yard, with inter-connections, through 50x6 MM flats, as explained before.
- The procedures to be observed stringently for making connections and joints between various elements of the earthing system are as follows:
  G.S. flat to Structure/flat - The G.S. flat should be welded to the metallic portion (leg)

of the
structure after thoroughly cleaning the surfaces to be welded. The length of the welding should be at least twice the width of the G.S. flat, e.g.-minimum 100 mm for 50x6 mm G.S. flat. Exactly similar procedure is to be adopted for joints between two G.S. flats.

G.I. wire to structure. The G.I. wire should be bolted to the structure after making an eye formation and kept tight with the help of spring and ring washer. Then, the entire arrangement should be welded.

G.I. wire to G.S. flat- The G.I. wire should be bolted and then welded to G.S. flat, as explained above.

G.I. rod to G.S. flat- The G.I. rod should be securely clamped to the G.S. flat with the help of bolts and washers and the entire arrangement should then be welded.

G.I. wire to G.I. pipe – GI wire should be bolted to the G.I. pipe and then welded, keeping in view the relevant precautions, mentioned before.

G.I. flat to G.I pipe – The GI flat should be bolted tightly to the G.I. pipe and then the connection should be welded.

Before making connections and joints, it should be ensured that, the elements to be joined have a clean metallic contact surface without any non-conductive coating.

2.1.117. EARTH GRID SYSTEM

Grid system of interconnected conductors forming a closed loop mesh is to be installed using 75x8 mm MS flat for peripheral and branch conductors. Interconnections are made by welding them. This earth grid will be laid at a depth of about 0.5 mtr. bonded to general mass of the earth by 3 mtrs. long earth electrode of solid MS rod (or pipe) of dia 25mm. The G.I. pipe 40 mm. dia 3 mtrs. long in the earthing pits, driven vertically.

It is to this earth grid that the transformer neutral, apparatus, frame work and other non-current carrying metal work associated like transformer tank, switchgear frame etc. are to be connected. All these connections should be made in such a way that reliable and good electrical connection is ensured. Aluminum/ other paint, enamel, grease and scale should be removed from the point of contact before connections are made. No part of the ground connection leads should be embedded in concrete.

Arrangement of connection of earth connection shall be as follow:

2.1.118. GI EARTHING PIPE

Earthing pipe should be made of 40 mm diameter ISI marked B class GI Pipe. 12 mm dia suitable holes on its circumference shall be made as per approved drawing. The pipe should be in one piece. No joints or welding would be allowed on its length. Clamps made of 50x6mm GI flat duly drilled with 12 mm size holes should be welded at the top end for connection of earth conductor.

Pipe used shall be 40mm NB diameter, ISI marked Galvanized Mild Steel Tubes continuously welded Electric Resistance Welded ERW/High Frequency Induction welded (HFIW)/Hot finished welded (HFW) type, conforming to IS-554-1985 with latest amendment of MEDIUM quality (Class B).

2.1.119. MANUFACTURE:

GI earth pipe (40 mm diameter & 3 metre long) shall be made of tubes which shall be made from
tested quality steel manufactured by any approved process as follows:

a) Electric Resistance Welded (ERW).
b) High Frequency Induction Welded (HFIW) and
c) Hot finished Welded (HFW).

Tubes made by manual welding are not acceptable.

2.1.120. DIMENSIONS:

The dimensions and weights of tubes shall be in accordance with Table-I and Table-II of IS: 1239 (Part- I)/1990 with latest amendments, subject to tolerance permitted therein. Necessary 12 mm diameter holes across the circumference shall be provided as per approved drawing. Drawings shall be approved by the owner before start of the manufacturing work. The tube, earthing pipe shall be provided with 50x6mm GS clamps on one end, one clamp is to be welded with the pipe and another is removable to enable measurement of earth resistance of the pit. Other end of the earth pipe should be cut half in slop to make it a sharp.

2.1.121. GALVANIZING:

Tubes shall be galvanized in accordance with IS-4736-1986 with latest amendment for not dip zinc coating of Mild Steel Tubes. The minimum mass of zinc coating on the tubes shall be in accordance with clause 5.1 of IS-4736-1986 (specification for hot dip zinc) and when determined on a 100mm long test piece in accordance with IS: 6745:1972 shall be 400 g/m2. The zinc coating shall be uniform adherent reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rust, stains, bulky white deposits and blisters.

2.1.122. HYDRAULIC TEST:

(Before applying holes) Each tube shall withstand a test pressure of 5 M Pa maintained for at least 3 seconds without showing defects of any kind. The pressure shall be applied by approved means and maintained sufficiently long for proof and inspection. The testing apparatus shall be fitted with an accurate pressure indicator

2.1.123. TEST ON FINISHED TUBES AND SOCKETS:

The following tests shall be conducted by the manufacturer of finished tubes and sockets.
a) The tensile strength of length of strip cut from selected tubes when tested in accordance with IS-
1894-1972, (Method for tensile testing of steel tubes), shall be at least 320N/mm2.
b) The elongation percentage on a gauge length of 5.65/so (where so is the original cross-sectional

area of test specimen) shall not be less than 20%.
c) When tested in accordance with IS-2329-1985 (Method for Bend test on Metallic tubes) the finished
tube shall be capable of withstanding the bend test without showing any sign of fracture or failure. Welded tubes shall be bent with the weld at 90 degree to the plane of bending. The tubes shall not be filled for this test.
d) Galvanized tubes shall be capable of being bent cold without cracking of the steel, through 90 degree round a former having a radius at the bottom of the groove equal to 8 times the outside diameter of tube.
e) Flattening Test on Tubes above 50 mm Nominal Bore: Rings not less than 40 mm in length cut from the ends of selected tubes shall be flattered between parallel plates with the weld, if any, at 90 degree (point of maximum bending) in accordance with IS-2328-1983. No opening should occur by fracture in the weld unless the distance between the plate is less than 75 percent of the original outside diameter of the pipe and no cracks or breaks in the metal elsewhere than in the weld shall occur, unless the distance between the plates is less than 60% of the original outside diameter.
The test rings may have the inner and outer edges rounded.

f) **GALVANISING TEST:**
Weight of zinc Coating: For tubes thickness upto 6 mm the minimum weight of zinc coating, when determined on a 100 mm long test piece in accordance with IS-4736-1986 shall be 400 grm/m2.
The weight of the coating expressed in gram/m2 shall be calculated by dividing the total weight of the zinc (inside plus outside) by the total area (inside plus outside) of the coated surface.
Test specimen for this test shall be cut approximately 100 mm in length from opposite ends of the length of tubes selected for testing. Before cutting the test specimen, 50 mm from both ends of the samples shall be discarded.
g) Free Bore Test: A rod 230mm long and of appropriate diameter shall be passed through relevant nominal bore of the sample tubes to ensure a free bore.
h) Uniformity of Galvanized Coating: The galvanized coating when determined on a 100 mm long test piece [see V (a) (iii)] in accordance with IS-2633-1986 (Method for testing uniformity of coating on zinc coated articles) shall with stand 4 one minute dips.

- **WORKMANSHIP:**

The tubes shall be cleanly finished and reasonably free from injurious defects. They shall be reasonably
straight, free from cracks, surface flaws, laminations, and other defects, both internally and externally. The screw tubes and sockets shall be clean and well-cut. The ends shall be cut cleanly and square with the axis of tube.

- **MARKING:**

The medium class of tubes shall be distinguished by Blue colour bands which shall be applied before the tubes leaves the manufacturers‟ works. Tubes shall be marked with the standard mark.

BATTERY CHARGER & DC DISTRIBUTION BOARDS.

2.1.124. SCOPE OF SUPPLY:

One set of 220 V Maintenance free sealed DC Batteries of 500-Ampere Hours capacity and one set of 24V maintenance free sealed DC Batteries of 500AH, one set of battery charger for 220V and 24 V system and one set of DCDBs for each system shall be provided The battery shall be able to support the complete station load for a period of 10 hrs, without AC supply.

2.1.125. BATTERY, BATTERY CHARGER AND DCDB

GENERAL :

This section covers the salient aspects and technical particulars of design, manufacture, testing, erection and commissioning of 220V, 500AH and 24V, 500 AH capacity, high discharging performance, maintenance free sealed stationary batteries, along with battery charging equipment consisting of silicon controlled rectifier type float chargers, Silicon diode type boost charger and D.C. distribution boards along with accessories.

SCOPE OF SUPPLY :

The scope of supply against this specification covers manufacture, assembly, testing at works, packing, supply by Road, delivery at Project site, erection, testing and commissioning of 220V D.C & 24 D.C. system .

1. a. 220V Bank, 500AH capacity high discharging performance, maintenance free sealed batteries along with accessories, fittings etc.1 No.

b Battery charging equipment for the above consisting of 1 No

i) Silicon controlled rectifier type float charger. 1nos.

ii) Silicon diode rectifier type boost charger 1nos.

c)D.C Distribution Board (220V) 1nos.

2 (a) 24V Bank, 500AH capacity high discharging performance maintenance free sealed lead acid batteries along with necessary accessories, fittings etc. 2nos.

(b) Battery charging equipment for the above (item 2) consisting of : 1 No

i) Silicon controlled rectifier type float charger : 1nos.

ii) Silicon diode rectifier type boost charger. : 1nos.

c)DC Distribution Board (24V): 1 No.

The batteries with associated equipment and accessories are required to provide continuous and reliable supply to respective boards of 220V and 24V DC Boards for various applications, viz control, protection, indication, annunciation, regulation panels of pump house and also for pump house emergency lighting.

SPECIFICATIONS AND STANDARDS FOR BATTERIES:

a) Stationary cells and batteries, lead acid type with tubular positive plates : I.S.1651

b) Stationary cells and batteries, lead : I.S.1652 acid type with plant positive plates

c) Sealing compound for lead-acid batteries I.S.3116

d) Valve Regulated Batteries BS: 6290 Part IV

SPECIFICATIONS AND STANDARDS FOR BATTERY CHARGERS.

a) Degrees of protection provided by enclosure for low-voltage switchgear and control gear : I.S.2147

b) Air Break switches, air break disconnectors and fuse combination units for voltages not exceeding 1000 Volts AC or 1200 V DC : I.S 4064

c) Contactors for voltages not exceeding : I.S.2959 1,000V AC or 1,200V DC

SALIENT FEATURES OF 220V, 500AH BATTERY :

1. Type of battery :Maintenance free sealed lead acid high discharging performance indoor type station battery.

2.Design ambient temp : 50 deg. C.

3.Rating :

i)Ampere hour capacity :220V, 500AH at 10Hr.

ii)End cell voltage after 10 hour discharge (Electrolyte temperature 27 deg.C.) Voltage of 1.75 V

iii) Rated voltage of Battery.

a)Nominal Voltage :220V

b)Maximum : 243 V
c)Minimum Voltage: 189V

4. Number of cells :110 (May vary depending upon the voltage of each cell at fully charged condition to maintain the nominal voltage)
5. Discharge current:
and cell end voltage Amperes cell end
of battery voltage.

a)1 minute load:460A 1.85V

b)2 Hr.emergency load : 135A 1.85V

c)10Hr.continuous load: 40A 1.85V
without trickle or
boost charging.

6.Nominal Cell voltage :2 Volts.

7.Ampere Hour efficiency : 90% Minimum

8.Watt Hour efficiency : 82% Minimum

9.Float charge current : 40A

10. Boost charge current: 100A (will not be less than the rate of Boost charge required for batteries plus station load of 40A)

11.Time required for:8-10 Hrs.
Boost charging from
discharge condition.

SALIENT FEATURES OF 24V, 500AH BATTERY

1. Type of battery: Maintenance free sealed lead acid high discharging performance indoor type station battery.

2. Design ambient temp: 50 deg.C.

Rating :

i) Ampere hour capacity 24V, 500AH at 10H
ii) End cell Voltage at 10 hour discharge rated (Electrolyte Voltage of 1.86V Temperature 87 deg.C) .

iii)Rated voltage of:

Battery.

a) Normal Voltage: 24 V
b) Maximum Voltage: 27 V
c) Minimum Voltage: 21 V

4. Number of cells: 12 (May vary depending upon the voltage of each cell at fully charged condi tion to maintain the nominal voltage).

5. Discharge current: Cell end of battery Voltage and cell end voltage Amperes

a) 1 minute load: 345A 1.85V
b) 2 Hr. emergency load : 100A 1.85V
c) 10 Hr. continuous load: 30A 1.85V
without trickle or
boost charging.

6. Nominal Cell voltage :2 Volts.

7. Ampere Hour efficiency:90% Minimum

8. Watt Hour efficiency :82% Minimum

9. Float charge current : 30A

10. Boost charge current :80-100A.(will not be less than the rate of boost charging required for
batteries) plus station load of 30A)

11. Time required for :8-10 Hours.
Boost charging from
discharge condition.

CONSTRUCTIONAL FEATURES (COMMON FOR 220V AND 24V BATTERIES):

1. Container and cover: Flame retardant special material
grade policy propylene

(v)

2. Thickness: 2-3 mm.

3. Separator Type: Highly absorbent glass mat separator.

Material: Spun glass microporous
matrix.

Thickness :3 mm (approx.)

4. Electrolyte: Prepared from the battery grade sulphuric acid confirming to IS 266:1961

5. Specific gravity of: electrolyte at 27 deg. (with cells fully discharged) 1.1

6. Specific gravity of fully : 1.2 +/- 0.005 corrected to 27 deg.C.

7. Type of positive plates : Flat pasted plate type with MFX alloy

8. Type of negative plates : Flat pasted plate type with lead calcium alloy.

9. Rack material : Mild steel.

10. Self discharge rate of: capacity per week. Less than 0.5% Battery.

11. Life of the battery : 20 Years.

12. Terminals : Integral lead terminal with solid copper core.

13. Connectors : Heavy duty, lead plated copper connectors.

CONSTRUCTIONAL DETAILS OF BATTERY(COMMON FOR BOTH 220V AND 24V SYSTEM:

Plates: Positive plates shall be made of flat pasted type using lead cadmium patented MFX alloy.

Negative plates shall be heavy, durable flat plate using lead calcium alloy pasted box grid. Negative palates shall be designed to match the life of positive plates and combination of positive and negative plates will ensure long life, durability and trouble free operation of battery.

Separators: Separator shall be made of spun glass, micro porous matrix and shall be resistant to sulphuric acid. It shall be capable of keeping all the electrolyte absorbed in the separator with no free electrolyte. It shall be electrically insulated. Internal resistance will ensure discharge characteristics under all operating conditions. Sufficient separator overlap to edges of the plate is to be provided to prevent short circuit formation between the edges of adjacent plates.

. **Containers and lids:** The containers and lids shall be made or a flame retardant special grade copolymer polypropylene. They shall be sufficiently robust and not liable to deformation under internal operating pressures and with in the temperature range naturally encountered, leak proof, non absorbent and resistant to the acid.

Containers will have adequate space at the bottom for collecting sediments for the entire life of the batteries.

Provision for by passing any defective cell during service for replacements etc may be made.

For identification each container shall be marked in a permanent manner to indicate the following information:

a) Cell number
b) Type of plate
c)AH capacity at 10 hour rate
d) Type of container
e)Manufacturer's name
f) Month and year of manufacture.

Sealing & Venting: Vent plug shall be made of suitable plastic material, pressure regulating, explosion proof and self resealing. Venting will only occur through porous disc. The vents will release excess pressure and reseal when the pressure is low.

Electrolyte: The electrolyte shall be prepared from the battery grade H2SO4 confirming to ISS:266. The batteries shall be supplied in factory filled and charged condition.

Water: Water required for preparation of electrolyte will confirm to IS :1069

Connectors: Connectors may be supplied either as separate bars or alternately as part of the cell structure i.e. as suitably elongated group bars or terminal lugs. The connectors shall be lead coated copper of suitable size to join the cells. The connectors which shall be of suitably designed copper connectors and suitably coated to withstand corrosion due to sulphuric acid may be used where the cells are called upon to discharge at very high rates. The coating should be adequate and tenacious.

Plate connections: Lugs of plates of like polarity shall be connected by lead burning to a horizontal strap having an upstanding terminal post adopted for connection to external circuit. Strap and post shall be cast with lead antimony alloy. The positive and negative terminal posts shall be clearly marked for unmistakable identification.

Nuts and Bolts: Nuts & Bolts for connecting the cells shall be effectively lead coated to prevent corrosion.

Terminals: Terminals shall be of Integral Lead terminal with Solid Copper Core.
Supporting racks: Batteries shall be installed on MS racks to be supplied by the contractor to fit in the battery/battery charger room. Layout of batteries in the battery room shall be approved by the Board.Racks shall be so designed that cells are located within easy reach at convenient height.
Minimum number of bolts and nuts should be used primarily for anchoring and joining. Joining will ensure proper and tight fit. Racks shall be painted with 2 coats off anti corrosive paint and supplied in unassembled state. Racks will also be provided with spray or dip coating for protection against fungus growth and other harmful effect due to tropical environment.

Charging:
Lower optimum voltage shall be maintained by chargers to maintain batteries in fully charged condition, for minimum evaporation and maximum battery life for both 220V and 24V DC systems. The tenderer will also specify life as well as boost charging cycling of the batteries is not envisaged.

Suitable means shall be provided for indicating and annunciating the fully discharged condition of the Battery of both 220V and 24V DC systems in control room.

Voltage:

The cell voltage will not exceed 2.25V with a continuous low rate of floating charge and will not be less than 1.85V at the end of emergency discharge.

Operation:

The DC battery shall be operated without an intentional ground. For indicating the incidence and degree of a ground fault on the DC control circuitry, the midpoint of the battery shall be earthed through a high resistance with an ammeter. The high resistance shall be so proportional that the current flowing under the worst earth fault will not exceed 100mA for 220V DC system and 25 mA for 24V DC system.

Ventilation:

The requirement of ventilation of the Battery room shall be finalized at the time of finalization of layout plant

Both 220V and 24VDC battery banks are proposed to be installed in the same Battery room. The layout of the battery (both for 220V and 24V) keeping in view the working space required. shall be finalized at the time of finalization of layout of plant.

CONTRUCTIONAL FEATURES OF BATTERY CHARGING EQUIPMENT:

a) BOOST CHARGER:

The boost charger shall be suitable for 3 phase, 50HZ, A.C. input supply. The charger shall be manual control type consisting of full wave silicon diode rectifier with suitable transient voltage suppression.

Suitable ripple filtering circuits shall be provided for the boost charger to limit ripple content in DC output.

The boost charger shall have dry type double wound transformer of suitable rating with adequate no. of taps on both primary and secondary sides for the change of output voltage/current control. OFF load tap changer will also be provided for boost charger transformer on primary side.

The boost charger shall have the control gear consisting of 2/4 position rotary switch for coarse and fine control of output voltage.

The boost charger shall have necessary protection to prevent the failure of diodes due to heavy currents from the boost charger when the battery is fully in discharged condition.

The boost charger shall be designed to charge a fully discharged battery without over loading or causing over voltage or without causing interruption of operation of AC or DC system. After the batteries recharged, the charger will maintain the battery at full charge.

The charger shall be provided with all necessary equipment and devices to protect the charger from short circuits, transient voltage surges, load and supply fluctuations including sudden loss of input or load.

b)FLOAT CHARGER :

The float charger shall be suitable for 3 phase, 415V, 50HZ AC input supply. The float charger shall be invariably Automatic type employing silicon controlled rectifiers with full half controlled bridge for voltage and current limit control.

The float charger will have built-in automatic voltage control and load limiting feature. The voltage regulator will automatically sense, monitor and regulate the DC voltage to within + or - 10% of the set value, from no load to full load and under supply voltage and frequency fluctuating conditions.

The float charger shall be designed to give higher output currents thus allowing a margin for future increase in load current or battery capacity.
Suitable control gear (Auto/Manual) shall be provided for smooth control of the voltage.
Suitable ripple filtering circuits shall be provided for the charger to give smoothing for DC output.
The boost charger will have dry type double wound transformer of suitable rating with adequate no. of taps on both primary and secondary side for the change of output voltage current control.
The charger shall be current limited at 125% of full load to reduce output voltage for charger circuit protection and protection of battery from over charge. The current limit shall be continuously adjustable from 80% -125%.
The float charger shall be provided with soft start feature which will make the DC output voltage to raise gradually to its rated value over a duration of 6-10 seconds whenever the charger is powered or at the time of restoration of supply.

COMMON FEATURES OF BATTERY CHARGING EQUIPMENT:

The battery charging equipment will capable of operating satisfactorily and delivering the rated DC output (220V/24VDC) with input A.C. supply voltage variation of + -5% of rated value.
The input supply for the battery chargers is 3 phase,415V, 50HZ A.C. supply for both 220V and 24VDC systems.

The ripple content of the battery charger will not exceed 3%

The battery charger equipment shall be supplied complete with all devices, bus bars, output terminals, earthing, links, cable glands for all external cables, rating plates etc. The tenderer will also supply necessary equipment like relays for adequate protection of the charger against faults.

Bidder shall furnish schematic diagram showing the general protection features provided for the charger along with the general layout diagram.

While boost charging the battery normal load shall be fed by float charger. In the event of failure of float charger the load shall be fed from 90% tap of the battery through suitable means.
In the event of incoming AC supply failure, when the battery is being boost charged the available battery capacity shall be automatically transferred to the DC bus.

The float and boost chargers shall be housed in individual panels, separately in complete shape with all necessary accessories mounted. The panels shall be indoor, floor mounting, free standing type. They shall be totally enclosed, complete dust tight and vermin proof. The thickness of the steel sheet of the panel shall be 3.0mm. The internal power and control wiring of the charger shall be carried out with PVC insulated 1100V grade stranded copper conductor wires. The control wiring shall be carried out with 2.5 sq.mm. copper conductor cable. Power and control wiring shall be wired in separate bunches/troughs.

The terminal blocks shall be stud type terminals of ELMEX make type cat M4 suitable for connecting external cables to be provided by the purchaser. The size of all such cables shall be finalized with the successful tenderer. All external cables to be connected to the charger shall be arranged for bottom entry.

Space heaters suitable for operation on single phase 240VAC system in both the charger panels along with the ON/OFF switch shall be provided

Illumination in the charger panels shall be provided with a tube light operated on single phase 240VAC system. Suitable earthing lugs shall be provided for each of the charger panels.
Padlocks shall be provided for the panels to prevent unauthorised access or operation of any equipment.

MCCBS :

MCCBS used shall be non draw out type. They shall be quick make/ brake type and shall be provided with thermal overload magnetic short circuit releases. The operating mechanism must be trip free.

FUSES :

All fuses shall be HRC non-deteriorating type. Unless otherwise specified, the fuses shall be of class 4 (80KA breaking current) for AC circuits and class 2 (33KA DC current) for DC circuits

INSTRUMENTS :

The instruments shall be moving coil type ISS and will withstand over loads as experienced in system without injury or change in calibration. They shall be flush mounting type and dust proof.

BUS BARS :

The bus bars shall be of tinned copper having adequate current rating and shall be continuous throughout each section.

CONTACTORS :

The DC contactors shall be suitable for uninterrupted duty, making & breaking the current of the associated circuits. Each contactor will have not less than 2 No and 2 No auxiliary contacts in addition to those required for contactor operation.

ACCESSORIES :

All accessories of batteries, battery charger and DC distribution board required for installation, operation and maintenance of the both and charger shall be provided.

PROTECTION SYSTEM :

1. AC overload protection. A thermal overload relay is to be provided at AC input side which on over current trips and opens the input contactor.
2. Over voltage protection: Over voltage Protection for any failure in regulating circuit is to be provided.
3. Protection against earth fault indicating continuous earth leakage shall be provided.
4. Fully discharged condition of the battery shall be indicated on battery charger panel.
5. The equipment should restart automatically on restoration of AC supply. The DC output will raise gradually to its rated value over a duration of 8-10 seconds.

DETAILS OF COMPONENTS OF BATTERY CHARGING EQUIPMENT

The Battery charging system will consist of the following equipment.

METERS :

Float charger panel :

a) AC Input voltmeter with selector switch 500V.
b) DC Ammeter. 0-50A
c) DC Voltmeter. 0-300V

Boost charger panel :

a.AC input voltmeter with selector switch 0-500V
b.DC Ammeter 0-60A
c.DC Voltmeter 0-300V

(vi) d. Battery ammeter with centre with suitable shunt 125 -0-25A 150-0-150A Zero.

INDICATIONS :

1. Neon type indication lamps shall be provided for
a. Boost charger AC input ON (R,Y,B phases)
b. Float charger AC input ON (R,Y,B phases)

2. Long life LED indicators shall be provided for the following conditions with audio alarm for fault conditions.

a) A.C. input fuse fail
b) D.C. output fuse fail
c) Contactors ON
d) A.C. input over load
e) Charger fail
f) Charger fuse fail
g) Charger over voltage
h) Output over load
i) Filter condenser fuse fail
j) Rectifier fuse fail
k) System output over voltage
l) System output under voltage
m) 105th cell in circuit/ 12th cell circuit
n) Battery low
o) Battery discharging
p) Battery earth fault
q) D.C leakage indicator (centre zero meter with -100 MA to +100 MA scale)

POTENTIAL FREE CONTACTS:

Potential free contacts (No contacts) shall be provided for following conditions in the respective panels.

a. Float charger fail
b. Boost Charger On
c. Battery low
d. Battery discharging
e. System under voltage.

MCCBS

a) For float charger input
b) For float charger output
c) For Boost charger input
d) For Boost charger output

SWITCHES :

a) Tap changing switch on B.C (Coarse/fine)
b) Battery input ON/OFF switch
c) system output ON/OFF switch
d) Space heater power supply ON/OFF switch
e) Panel illumination power supply ON/OFF switch

PUSH BUTTONS FOR THE FOLLOWING:

A) Float charger ON and OFF
B) Boost charger ON and OFF
C) Lamp test
D) Alarm silence

CONTACTORS FOR :

a) Boost charger
b) Float charger
c) D.C. contactor to connect 220VDC/24VD bus.

PROTECTION :

a) HRC Fuses at AC Input
b) Fast acting fuses for semiconductor devices protection.
c) AC Input over load
d) DC over voltage
e) Float charger over current
f) Thermal O/C relay Boost Charger.
g) Thermal O/C relay Float charger.

TRANSFORMERS :

a) Boost charger Transformer
b) Float Charger Transformer
c) Transformer for gate pulse power supply.
d) Current Transformers to limit over load
e) Filter choke.

PROTECTION CLASS : IP 42

CONSTRUCTIONAL FEATURES OF D.C DISTRIBUTION BOARDS:

The D.C. distribution Boards shall be rated for 600VDC and 30VDC respectively distinct from charger equipment. D.C. distribution boards shall be supplied separately both for 220V and 24V D.C. Systems.

The D.C. distribution board will consist of DC MCCBS for controlling the incoming supplies and for various out going feeders along with indication lamps to indicate `ON' condition of MCCB.

The D.C. distribution Boards will comprise necessary earth leakage indication device, bus bars, all internal connectors, earthing connections wiring etc., as required.

The distribution boards to be supplied shall be made of cold rolled sheet steel and suitably dimensioned. The thickness of the steel will not be less than 3.0mm.

DETAILS OF 220V D.C. DISTRIBUTION BOARDS:

The D.C. distribution Boards offered will comprises of two sections two numbers incoming feeders (one shall be closed at a time) with 400A DC MCCB,of 220V DC shall be provided for connecting to Battery Bank which shall be common for both sections.

a)220VDC Distribution Board: Section-I
Out going feeders :

1)15 Amps DC Double pole MCCBs : 32 Nos.
(16 Nos for each unit, Total for 3 pumps)

2)Under voltage relay : 1 No.
b) 220V DC Distribution Board : Section-II

1) 30 A feeders : 2 Nos.
2) 15 A feeders : 40 Nos.
(common for all pumps and switchyard equipment)
For each feeder "ON" indication lamp or LEDs hall be provided
c)24VDC distribution Board
(vii) Incoming feeder from 24 V Battery : 1 No.
bank with 100 A DC MCCB

The 24VDC distribution shall be provided with the following outgoing feeders on the suitable MCCBs

16Amps DC double pole MCCBs: 15 Nos.
30 Amps DC double pole MCCBs : 4 Nos.

For each feeder "ON" indication lamp or LED shall be provided

.The prior approval shall be taken for the drawings before manufacturing the distribution Boards.
TESTS :

The routine and type tests on the equipment viz. battery, battery chargers, DC distribution boards shall be carried out at works. The capacity test on Battery at site shall be carried out after commissioning. Should the capacity test of battery is found lower than the specified, the supplier will rectify defects at his cost. The Purchaser reserves the right to reject the battery, if ultimately the battery is found lower than the specified rating.

BID DATA, DRAWINGS, AND INSTRUCTION BOOKS:
Layout of battery room, calculations for battery capacity, operation and maintenance instruction books shall be submitted.at the time of detailed engineering

NOISE: All apparatus will operate without excessive vibrations and with the least practicable amount of noise.Terminal Blocks.

Sealed Maintenance Free (SMF / VRLA) battery and charger with static control circuits and Thyristor bridge rectifiers with complete automatic voltage, current regulation.

Type of battery:Maintenance free sealed lead acid high discharging performance indoor type station battery.
Nominal Voltage:220 Volts
AH efficiency:90% minimum
Watt Hour efficiency:82% minimum
Time required for Boost :8-10 Hrs
charging from completely
discharged condition
Nominal life of battery :20 Years
Terminals :Integral lead terminal with solid copper core
Connectors :Heavy duty lead plated copper connectors.

The battery charger will consists of boost and float chargers. The rectified DC shall be fed into Main DCDB. From this the DC supply shall be extended to individual panels through MCBS of suitable rating ONE MCB shall be provided for each function panel independently.

1. **List of Mandatory spares for VT Pumps.**

I. Complete impeller with impeller Nut 1 no for Each type of Pump
II. Impeller wear ring 1 no for Each type of Pump
III. Set Shaft sleeve 1 no for Each type of Pump
IV. Set of Thrust bearings 1 no for Each type of Pump
V. Set of Throdan bearings 1 no for Each type of Pump
VI. Set of wearing rings 1 no for Each type of Pump
VII. Set of couplings 1 no for Each type of Pump
VIII. Gland packing/mech. Seal set 1 no for Each type of Pump
IX. Set of packings and gaskets 1 no for Each type of Pump
X. Set of fasteners 1 no for Each type of Pump

List of Mandatory Spares for EOPD/HOPD Valve:

I. Seats ring and seal ring 1 no for Each type of Valve
II. Actuator gear box ` 1 no for Each type of Valve.
III. Actuator complete unit 1 no for Each type of Valve
IV. Actuator control cards 1 no for Each type of Valve
V. Actuator Power cards 1 no for Each type of Valve
VI. Limit switches for actuators 1 no for Each type of Valve.

2. **List of Mandatory Spares for Motor:**
   I. Motor Bearing set 1 no for Each Rating
   RTDs used for air circuits & bearings 20% of total quantity.
   II. Cooling Fans 1 no for Each Rating.

3. **List of Mandatory Spares for VFD:**
   I. VFD 1Nos. for Each Rating
   II. Bypass contactors 1Nos. for Each Rating
   III. Multipliers Contactors 1Nos. for Each Rating
   IV. Thermal Relays 1Nos. for Each Rating.
   V. Timers 1Nos. for Each Rating

4. **List of Mandatory Spares for Switch gear Panels**:
   I. Circuit Breaker 1Nos. for Each Rating
   II. Current transformers 1Nos. for Each Rating
   III. Potential Transformers 1Nos. for Each Rating
   IV. Spring Charge Motors 1Nos. for Each Rating
   V. Protection relays 1Nos. for Each Rating
   VI. Indicating and recording Meters 5% of total quantity
   VII. Selector switches (each type) 5% of total quantity
   VIII. Indicating Lamps 20 Nos for each type and color

5. **List of Mandatory Spares for LT Distribution Panels(SAB):**
   I. LT Contactors 1 No. for Each Rating
   II. MCB/MCCB 1 No. for Each Rating

III. Switch fuse Unit 1 No. for Each Rating
IV. Indicating and recording Meters 5% of total quantity
V. Selector switches 5% of total quantity
VI. Indicating Lamps 20 Nos for each type and color

6. **List of Mandatory Spares for Battery and Battery charger:**
   I. Thyristors/SCR 5% of total quantity
   II. Diodes 5% of total quantity
   III. Multipliers Contactors 5% of total quantity
   IV. Multipliers Contactors 5% of total quantity
   V. Control cards 1 No. for Each type
   VI. Control transformers 1 No. for Each type
   VII. Indicating Lamps 5 Nos for each type and color
   VIII. All types of PCB 1 set

7. **List of Mandatory Spares for EOT Cranes:**
   I. Thrust Breaks 7 Nos.
   II. Coils for Break solenoids 1 Set
   III. Control contactors 5% of total quantity
   IV. Brake pads/Linings 5% of total quantity
   V. Fuses 5% of total quantity
   VI. Limit switches 2 Nos.
   VII. Bearings 1 No. for Each type
   VIII. Oil seals 1 No. for Each type
   IX. Carbon Brushes 1 set
   X. Fuses all ratings 1 set

List of Special Tools, Instruments and T&P.

1) Chain block (special) 1 set
2) Separating bolts (Special) 1 set
3) Special Spanners for Pumps 1 set

List of testing instruments for electro mechanical equipment

The following testing instruments and equipment shall be supplied for testing of Pump Motor sets (units).

1) A.C. Analog / digital Voltmeter,
    a. 0-150 / 300V 1No.seach
    b. 0-75 / 150V 1No.seach
2) A.C. Analog / digital Ammeter, 0-1/5A, 0-5/25A 1 No.seach
3) Analog Watt meter 3 Phase, 1/5A, 600 V 0.5 class 1 No. each
4) Frequency meter (Digital), 45-55 Hz & 1 No.
5) D.C. Analog / digital Voltmeter, 0-100m V. 0-100V/300 V2No.s
6) D.C. Analog / digital Ammeter 0-1/5A. 0-5/25 A2 No.s
7) Phase angle meter Analog, 120/240 V.
   50/60 Hz 0.5/1A. & 2.5/5A. 1 No
8) Phase rotation meter, AC, 60 V-500V 1 No.
9) Wheatstone Bridge, 0.0001-10 ohms 1 No.
10) VAR Meter Analog 2.5/5A, 120V, 0.5 Class 1 No.
11) Earth megger500V 1 No
12) Single Phase Variac, 0-250 V, 15 A 2 Nos.
13) 3 Phase Variac 0 -500V, 15A 1 No.
14) Testing Transformers:
    a. 1 Ph. 30 KVA, 220/30 V, 1000A 1 No
    b. 3 Ph 440 V, 0 to 50 A. 1 No.
15) DC High voltage testing kit, 0 to 60 KV/10 mA 1 No.
16) Megger Digital, 500 V, 1000 M ohm 2 Nos.
17) Megger Digital, 1000V, 2000 M ohm 2 No.
18) Motor operated Megger 2.5 KV/5 KV (Digital)2 No.
19) Oscilloscope dual champed storage 1 No.
20) Stop watch, 1/5 sec. (60 sec.) 4 Nos.
21) Electric Hand tachometer (Digital) (0-3000 rpm)7 Nos.
22) Manometer Gauge Tester 0.05 kg/cm2 7 set
23) Manometer Gauge Tester 2.50 kg/cm2 7 set
24) Manometer for oil use, 0-50 kg/cm2 7 sets.
25) Manometer for water use 7 sets.
26) Resistance box, 6 element 7 No.
27) Open Angle measuring tool 7 set
28) Shunt, 5A or 7.5 A/50 mV 7.No.
29) Bell, 220 V DC. 7 Nos.
30) Elec. Soldering iron, 230 V AC 100W (with temp. control).7 Nos.
31) Noise Meter A/B/C range 7 No.
32) Hand Operated crimping tool 2 Nos
33) Hydraulic operated criping tool 2 Nos
34) Vernier calipers 150mm, 300mm 2 Nos.
35) Pitch gauge 2 Nos.
36) Depth micro meter0 to 50mm, 0 to 400mm 2 Nos.
37) Inside micro meters25 mm to 1 meter 2 Nos.
38) Out side micro meters 0 to 150mm, 0 to 300mm 2 Nos.

39) Slip gauge up to 100mm 1 No.
40) Straight edge150mm, 300mm and 1 meter 1 No.
41) Telescope gaugeup to 150mm 1 set
42) Dail gauges 8 Nos
43) Vibration Meter 2 No.

Range 1 to 1000 mm/sec2, Velocity 0.1 – 100 mm/sec. with recorder.

I. List of Tools and plant:

The following tools and equipment shall be supplied for regular operation & maintenance of pump units.

1) Double end ring spanners 6mm to 36mm 7 sets
2) Open end type spanners 6mm to 36mm 7 sets
3) Box spanners with ratchet handle and extension rod. 6mm to 36mm 7 sets
4) Feeler gauge0.01mm to 2.5mm 7 sets
5) Screw drivers with insulation 150mm to 600mm 7 sets
6) Cutting player with insulation 7 sets
7) Bearing Pullers varies sizes 7 sets
8) Aluminum ladders 30 feet, 50 feet,100 feet 7 No.
9) Drilling machines 6mm, 13mm and 25mm 7 Nos.
10) Welding Transformer 230 V, 300 A to 600 A 7 No.
11) Portable welding machine0 to 150 A 7 Nos.
12) Bench grinder 150mm 7 Nos.
13) Horizontal grinder 100mm 7 Nos.
14) Angel grinder 180mm 7 Nos.
15) Flexible shaft grinder 7 Nos.
16) Vacuum cleaners heavy duty, 230 V. 7 Nos.
17) 'D' shackles 3T, 5T and 10T 7 Nos.
18) Slings (Steel) 8 mtrs. Length3T, 5T and 10T 7 Nos.
19) Portable Hot air blower 7 Nos.
20) Oxygen regulators 7 sets
21) Blow pipe set 7 sets
22) Tap sets6, 8, 12, 16, 20, 24mm 7 sets
23) Hammers (Steel) 2, 6, 8 LBS 7 Nos.
24) Hacksaw frame 300 mm 7 Nos.
25) Sheet metal cutters300 mm 7 Nos.
26) BSP taps¼ , ½, ¾ and 1inch 7 sets
27) Chain block pulleys.1 T, 3 T and 5 T 7 Nos.
28) Bench vise 8 inches 7 No.
29) Surface plate 400 mm 7 No.
30) Pipe bending Kit. 7 No
31) Align keys 7 set

All the above spares, T&P, Testing instruments to be supplied 2 sets in total.

Pre-commissioning Trials

4.1 Start up

On completion of the erection of equipment and before start up, each item of the equipment shall be thoroughly cleaned and then inspected by the Engineer in charge and the contractor jointly for correctness and completeness of installation and acceptability for startup leading to initial pre-commissioning tests at site. The list of pre commissioning tests to be performed shall be mutually agreed and included in contractor's quality assurance Programme. The contractor's commissioning /start up engineers specially identified as far as possible shall be responsible for carrying out all pre-commissioning tests. On completion of inspection, checking and after pre-commissioning tests are satisfactorily over the complete equipment shall be placed on initial operation during which period, the complete equipment shall be operated integral with sub-system and supporting equipment complete plant.

4.2 Commissioning spares

The contractor shall make Arrangements for an adequate inventory at site, of necessary commissioning spares prior to commissioning of equipment furnished and erected so that any damage or loss during these commissioning activities necessitating the requirements of spares will not come in way of timely completion of works under contract.

4.3 Registration and statutory Inspection

All the registration and statutory inspection fees if any in respect of work pursuant to this contract shall be to the account of contractor. Should any such inspection on registration need to be re-Arranged due to the fault of contractor, the additional fees for such inspection shall also be borne by the contractor.

4.4 Progress Reports and Photographs

During various stages of works in pursuant of the contract the contractor shall at his own cost submit periodic progress reports as may be reasonably required by the Engineer in charge with such materials as charts, networks, photographs, test certificates etc. Such progress reports and photographs shall be in the form and size as may be required by the Engineer in charge and shall be submitted in at least three copies and shall contain the date, the name of the contractor and the title of the photographs. The report shall also indicate reasons for variance between the schedule and actual progress and the action proposed for corrective measures whatever necessary.

4.5 Work and Safety Regulations

a) The contractor will notify the Engineer in charge of his intention to bring on to the site any equipment or any container with liquid or gaseous fuel or other substance, which may create hazards. The Engineer in charge shall have right to prescribe the condition under which such equipment or container may be handled and used during the performance works and the contractor shall strictly adhere to such instructions. The Engineer in charge shall have the right to inspect any construction plant and to forbid its use if in his opinion it is unsafe, no claim due to such prohibition shall be entertained by the owner.

b) Where it is necessary to provide and / or store petroleum products or petroleum mixtures and explosives the contractor shall be responsible for carrying out such provision and/or

storage in accordance with the rules and regulations laid down in Petroleum Act 1934 Explosive Act 1948 and petroleum and carbide of calcium manual. All such storage shall have prior approvals necessary from chief Inspector of Explosives or any Statutory Authorities. The contractor shall be responsible for obtaining the same.

4.6 Electrical Safety Regulations

a) In no circumstances will the contractor interfere with the fuses and electrical equipment belonging to the owner or other contractor

b) Before the contractor connects any electrical appliances to any plugs or sockets belonging to owner or other contractor he shall

1) Satisfy the Engineer in charge that the appliances are in good working conditions.

2) Inform the Engineer in charge of maximum current rating voltage and phases of the appliances.

3) Obtain the permission of the Engineer in charge, detail the sockets to which appliances may be connected.

c) The Engineer in charge will not grant permission to connect until he is satisfied that

1) The appliance is in good condition and is fitted with suitable plug.

2) The appliance is fitted with suitable cable having two earth conductors one of which shall be an earthed metal sheath surrounding the core.

d) No electric cable in use by the contractor shall be in use by the contractor/owner will be disturbed without prior permission.

No weight at any description will be imposed on any such cable and no ladder of similar equipment will rest against or to be attached to it.

e) No work will be carried out on any live equipment. The equipment must be made safe to work issued before any work is carried out.

f) The contractor shall employ the necessary number of qualified full time electricians to maintain the temporary electrical installation.

Contractor shall make necessary Arrangements for the following

I) It is necessary to carry out the testing of number of equipments in the manufacturers works. This is stated in the item wise specification. However the items, which require third party inspection as tested below with brief requirement of tests.

II) The Arrangements for this shall be Arranged by the contractor, the cost of testing in factory payable to manufacturer (including power charges etc.) The testing fees of inspecting authorities etc. shall be Arranged by the contractor without any extra cost to the department.

Whenever department Engineers will be attending the inspection and testing to and fro charges will be born by the department as per Govt. civil service rules. However all other Arrangements shall be made by the contractor.

5.1 Pipe work

M.S. pipe work shall be fabricated from M.S. plates confirming to IS 226. The fabrication pipe shall generally confirm to IS 3589 pipe and specials shall be fabricated from 10 mm and

8/6 mm thick plate as per drawing. Layout of valve and pipe work shall be got approved from the department. Dished end shall be provided at the end of the common manifold and thickness of dished end shall not be less than 12 mm.

Air release Arrangements shall be provided after the discharge head by using 50mm diameter G.I./ M.S. pipe and cock. Joints connecting the valves shall be flanged with flange thickness not less than 25mm joint rubber ring for these joints shall not be less than 3 mm.

The pipe work shall be subject to test pressure of 1.5 times the actual working pressure in the presence of the Engineer in charge.

All the pipes and valves shall be painted with the primer red oxide paint after the surface is cleaned and two coat of enamel paint of approved quality and shade to have finished aesthetic appearance. Cost of breaking the holes in walls and remaking the same as it was is included in this item.

5.2 Dismantling joints –

These shall be provided connected to the flange outlet or discharge head of the pump and Non Return valve. The diameter of this joint shall be same as Non Return valve. This shall be fabricated from M.S. plate designed to withstand pressure of 25 kg/cm2. The plate thickness shall not be less than 10 mm. The design of the joint shall ensure that no forces are transmitted to the pump foundation and flanges of dismantling joints are held rigid during normal working. For dismantling it shall be possible to slide the flanges at one end by at least 25 mm to enable dismantling refitting, General Arrangements drawing shall be got approved before actual fabrication of the joint.

6 ELECTRICAL EQUIPMENTS

I) Electric motors

There shall be vertical, hollow/solid shaft flange mounting type, to operate on 415 volts +/- 10% 3 phase 50 Hz. A.C. supply. The design of motors shall confirm to IS 325. The torque speed and current speed characteristics of motor shall be suitable for pump starting characteristics. The motor shall be designed such that there shall be minimum 10/15% reserve power over the entire head range of pump specified. H.P. of the motor. Starting time and locked rotar with stand time under hot conditions shall have suitable discrimination for proper selection of protection relays. The locked rotar withstand time under hot condition and at 85% rated voltage shall be more by at least 3 seconds than the starting time with driven equipment coupled at 85% rated voltage.

The motor shall be suitable for restricted operation at following conditions.

(a) Accelerating the driven equipment from stand still to full speed within duration of 1 minute or less at 85% of rated voltage.

(b) Operation on load at 75% of rated voltage for five minutes

(c) Two starts at quick succession for cold condition

(d) One hot restart at maximum steady state temperature over ambient temperature 45^0c .

(e) Three starts per hour equally spaced over the duration after attaining thermal equilibrium.

(f) The motor shall be of continuous duty ‘S-1’ class. The class of insulation of motor shall be ‘F’ class.

Constructional features

The motor shall be vertical, hollow shaft. The motor shall be statically and dynamically balanced and critical speed shall not be in the range of 80% to 120% of motor speed R.P.M. and direction or rotation of motor shall be same as that of pump.

The motor shall be squirrel cage induction type, with S.P.D.P. construction with degree of protection confirming to IP 24. At least two drain holes shall be provided at the bottom end of the frame.

The motors shall be provided with special designed heavy duty thrust bearing anti friction grease lubricated type to take entire load of pump and motor static and dynamic type. Terminal box shall be designed suitably to accommodate armored aluminum conductor of required rating and shall be manufactured by the motor manufacturer. Suitably designed non-reverse ratchet Arrangements shall be provided to the motor to stop reverse rotation.

(Note – As the V.T. pumps provided are suitable for hollow shaft motor necessary provision of special thrust bearing to take entire thrust a motor pump set shall be made along with non reverse ratchet and clutch type pump motor coupling at top as specified in the pump) as required.

Testing

The motor shall be offered for routine test to the inspecting Authorities and test certificates shall be submitted to the Engineers in charge.

Following document shall be furnished after contract is awarded.

a) General Arrangements drawing
b) Instruction manual for erection and maintenance
c) Test report
d) Torque speed curve

(ii) Auto transformer starter –

Fully automatic A. T. starter motor control panel assembled locally with the contactors of approved makes sheet metal clad enclosure, floor mounting type suitable for operation on 400/440 volts 3 phase 50 cycles A.C. power supply and fitted with

1. Oil immersed Autotransformer with 40%, 50%, 65% and 80% tapings. (Winding of transformer shall be copper only) with withstand capacity for at least six starts per hour. **Transformer will be inspected by third party before dispatch.**

2 Air break contractors of suitable rating, as under of AC3 duty class shall be provided.

3. Bimetallic thermal over load relay.

4 Timer on delay OFF

5 Ammeter and voltmeter with C.T.'s and selector switch

6 No volt release

7 Single-phase current sensing relay.

The wiring on the contactors shall invariably be carried out by using solid copper conductors. The appearance and layout in the panel shall be aesthetic and specious to facilitate easy working. The enclosure shall be factory finished specious and elegant looking and provided with ISMC 75 M.S. base channels painted with best quality enamel paint or powder coated. Interlocking shall be provided so that the panel door shall not be opened when panel is on or

alternately the panel should trip in case of opening of door. Contractor shall submit dimensional drawing of the starter, details of the offered components wiring diagram of panel etc. Indicating lamps for three phases On OFF and TRIP shall be provided on the front. Special terminal boxes for incoming and outgoing shall be suitably designed and provided to facilitate easy entry of power cables.

The starter panel shall be tested in the manufacturers work for functional requirements H.V. tests etc. by the competent authorities of the department.

Approved makes of Contactors

L&T / Siemens / Bharatiya Cultter Hammer Adrew yele/Crompton.

ii) Relays L&T Crompton A.B.B.E.E., Siemens

iii) Timer – L&T, Siemens.

iv) Ammeter and Voltmeter A.E. IMP RISHABH

v) Auto Transformer approved standards make.

L.T. Panel

General

L.T. panel comprising 415-Volt switch gear and control gears shall be suitably designed for the functions as under

a) Reception of power from Transformer

b) Distribution of power for pump motors, lighting etc.

Panel Construction

The 415-grade switch gears shall be housed in a totally enclosed sheet metal clad dust and vermin proof of cubicle suitable for floor mounting and are of equal height. The panel shall incorporate the following

i) 3 ½ pole 400A Aluminum bus bars in enclosed compartment in horizontal formation C.

ii) Enclosed vertical bus bar serving the motors

iii) No of identical separate compartments for motor feeders, instruments bus bars, C.T., P.T. cable termination as required.

iv) Internal panel barriers in the bus bar Chamber shall be epoxy.

The panel shall be fabricated from 2 mm thick M.S. sheets. Hinged doors shall be provided at the front and rear with car type handles. Mechanical interlocks shall be provided to prevent the opening of front door in ON position or alternately Arrangements shall be made to trip the supply in event on opening or front door. Suitable stopper shall be provided to restrict the opening of the doors to working requirements and to prevent the rubbing of the door and scratching of paint with adjoining panel structure. Cable entries and exits shall be from the

bottom only. Indicating and opening devices shall preferably be at uniform levels and shall not be above 1600 mm from the floor.

The panel framework shall have minimum ISMC 75 channel for base. Angle framework shall be 40 x 40 x 5 mm size M.S. angles.

Bus bars

The bus bars shall be aluminum sections to carry 400 A rated current (minimum) continuously. The bus bar shall be covered with shear resistant P.V.C. sleeves with color code and joints shall be epoxy shrouded. The bus bars shall be supported on durable non-hygroscopic supports rigidly fixed to the framework.

Adequate clearance shall be kept between the bus bars as per relevant IS codes.

Panel cabling and terminations

Power cabling shall be done entirely with P.V.C. insulated 1.1kV grade cables of size designed in confirming with relevant I.S. and shall not be less than 2.5Sq.mm. control cables shall be 650 V grade insulated copper cable not less than 1.5 sq. mm. however the cable for current transformer shall be 2.5 sq. mm or above. Cost of power and control cables in the panel shall deem to be included in cost of panel.

The terminal blocks shall be one piece moulded and screwed type. At least one spare terminal block shall be provided in each panel. Control cable shall neatly run over P.V.C. cable trays and shall be terminated in compression type terminal blocks. Identification codes as approved by the engineers shall be used for cable terminations. Ferrules shall be used for multi core cables.

Current transformers

The current transformer's for metering shall be wound/bar type and shall be rated for 21 KA fault level.

Painting

The panel shall be painted as under primer coat – one coat of red oxide. Intermediate Coat – Enamel paint of shade approved Final coat – Enamel paint as above.

Labels and Danger marks

Scheme of labeling shall be as under

a) Each compartment door shall have title label. The component/ control on each compartment shall have function label.
b) Each internal component and fuse shall have identification label with fuse current capacity where applicable.

All external labels shall be clear painted black in English all internal labels with crome plated nuts and bolts. Size of label shall be 50 mm x 25 mm with height of letter 5 mm.

Compartments not interlocked to an insulator shall have an external danger mark as under "DANGER, LIVE TERMINAL" with flash mark and voltages in red letter on white background.

Capacitor

All the pump motors shall be provided with suitable capacitor banks for improving power factor to 0.95 lagging at normal duty conditions. However KVAR selected shall not exceed 90% of the magnetising KVAR of the motor even if corrected P.F. is less than 0.95 lagging but not less than 90% in any case. The capacitor shall be suitable for operation at rated voltage [415 volts +- 10%] and shall be connected in respective power circuit of the motor with isolating switch tube units.

Capacitor bank shall be complete with structure, earth wire, discharge resisters etc. The capacitor shall be low loss mixed dielectric construction of polypropylene and craft paper insulated aluminum foiled type impregnated with non PCB non toxic non hazardous non flammable synthetic di-electroral oil and fitted with internal element fuse conforming to IS 2834/1981 revised and shall be with ISI mark separate panel shall be fabricated for housing these capacitors.

Testing

The capacitor shall be tested for routine test as specified in IS 2834 and test reports shall be furnished.

Contractor shall Arrange thermal stability test on the unit in the presence of the Engineer In charge.

Cables

Power cable used in 415 Volts system shall be 1.1KV grade 3 ½ core as applicable aluminum conductor P.V.C. insulated P.V.C. sheathed flat steel armored type confirming to IS 1534.

Cable shall be of sizes rated to carry full load current at 0.85 P.F. or to withstand short circuit current 20 KA for duration at least to opening of associated breaker whichever is greater but shall not be less than the size specified in subsequent clause.

Approved make for power cables/cables schedule – Tropodour /Finolex/Asian/ Gloster / Incab / universal / poly cab Nico

Cabling methods

Cables shall be laid in ground ducts and on trays in and out of pump house through R.C.C. trenches etc. with clearance not less than 600 mm below the water mains. Every cable shall be neatly run vertically, horizontally or parallels to adjacent wall, beam or column. At both ends of terminations the cable shall be approached from a common direction and are individually terminated in all orderly and symmetrical fashion.

The cables shall be terminated in mechanical glands that shall be suitable to provide adequate support by locking on the armour and additional earth continuity. Suitable compression type copper cable lugs shall be used for cable terminations.

The point of entry, exit of cables from the building shall be sealed from out side with an approved asbestos compound followed by 40 mm thick bituminous compound with sealing.

Cable route markers of approved design shall be installed at following positions

a) Entry and exit points of underground duct/trench

b) Exit from building

At every 5 meters distance of straight run

Any other position to trace the route.

A metallic plastic tag bearings cable reference number indicated in cable schedule at every 4 run to part thereof and at both ends shall be provided for case of identification and route tracing. The schedule shall be prepared by the contractor and submitted for approval.

The cable routes shall be such that sharp bench and kinks shall be avoided. The radius at bends for PVC insulated cables shall not be less than twice/thrice the overall diameter of the cable. Laying and termination of 1.1 Kv grade cable shall be as per manufacturers instruction as per practices specified code electrical manual. The cable underground shall be laid as per respective IS and practice in force and as directed by the Engineer In charge.

Loop/extra lengths shall be provided in each cable run located suitably. The loop/extra lengths shall be adequate for two straight through joints as and when needed.

Earthing

Effective earthing shall be provided to all electrical equipments and components. This shall be carried out with G.I. pipe electrode. Buried 2500 mm below ground including excavation of pit in all types of strata with charcoal salt and necessary alum etc. Strip, funnel Arrangements for watering and brick masonry chamber with C.I. frame and cover etc complete as per IS3043 and as per E.I. rules amended up to date.

The electric motors, L.T. panel starter, capacity etc shall be provided using double earthing with G.I. strip of size 25 mm x 3 mm with two independent earth pits. The pipe earth electrodes of 40 mm dia 2.5 m depth shall be used.

Earth pits shall be filled with charcoal salt and alum. They shall be provided with non hole frame and cover at top and water connection for watering the pit at intervals.

The earthing shall be carried out as per IS 3040 of 1966 and amended up to date and I.E. act 1948 amended up to date.

Ground bus or section 25 x 3 mm G.I. strip shall run through out the L.T. panel and shall be bolted to the framework.

All equipment shall be provided with two independent earthing connections and connected to earth strip.

Earth G.I. wire 6 S.W.G. shall run along with the cable from L.T. panel of pure water pumps to incoming of panel for ensuring safety and provide independent earthing to cable. This wire should be connected to armor or cable and cable end boxes at starting and end points.

Illumination to the pump house.

Necessary illumination shall be provided in and out at pump house as per specification given below.

External Illumination

i) This shall be as per direction of Engineer in charge.

Internal Illumination

Internal illumination in pump house and attendant room should be done as per direction of Engineer in charge.

Internal wiring shall be carried out with suitable size copper conductors P.V.C. insulated in appropriate size; M.S. conduit wooden block shall be provided wherever required. Separate wooden board tick wood polished shall be provided mountains the switches etc. Four power plug points with separate switches shall be provided.

8. Test Trial and operation

The plant shall be on trial operation for six months after testing during which period all necessary adjustments shall be made while operating over the full load range enabling the plant to be made ready for performance and guarantee test.

The duration of trial operation of the complete equipment shall be at least three months, out of which at least 72 hours shall be of continuous operation with full load or any other duration as may be agreed to between the Engineer in charge and the Contractor. The trial operation shall be considered successful, provided that each item of the equipment can operate continuously at the specified characteristics for the period of trial operation. Minor interruptions not exceeding four hours at a time, caused during the continuous operation shall not affect the total duration of trial operation. However, if in longer, the trial operation shall be prolonged for the period of interruption.

A trial operation report comprising observations and recordings of various parameters to be measured in respect of the above trial operation shall be prepared by the contractor. This report, besides recording details of the various observations during trials run shall also include the dates of start and finish of the trial operations and shall be signed by the representatives of both the parties. The reports shall have sheets, recording all the details of interruptions occurred, adjustments made and any major repairs done during the trial operation. Based on the observations, necessary modifications/ repairs to the plant shall be carried out by the contractor to the full satisfaction of the Engineer In charge to enable the latter to accord permission to carry out performance and guarantee test on the plant. However, minor defects which do not endanger the safe operation of the equipment shall not be considered as reasons for withholding the aforesaid permission.

Commissioning and Operation

After commissioning and testing, there will be six months trial run and thereafter five years for operation and maintenance of the plant.

During trial run and O & M period, the contractor shall depute his personnel full time to operate, maintain and repair the equipment. The personnel so deputed shall maintain log books and other records as directed by the Engineer In charge. During this period the owner's personnel shall continuously work with Contractor's personnel to take full responsibility of operating, maintaining, repairing, etc. of the equipment plant.

Civil works:

Following civil works are required to be carried out for installation transformer pole structure, fencing gates etc.

The general specifications are given below. However the general Arrangements and the layout or the substation shall be as per drawing approved by the statutory authority.

a) **Transformer platforms**- Suitable size of platform shall be provided for the transformer in 1:2:4 cement concrete as shown in the layout. The height of the transformer shall be such that the live terminal of the transformer shall be at a distance of 4m above the ground level of the transformer ground or as stipulated in I.E. rules amended up to date. The concrete work shall be carried out as per regular civil Engineering practice with excellent finished work. Necessary recess shall be provided to accommodate the outgoing cables --- for L.T. side of two transformers.

Two numbers of M.S. channels shall be embedded on the top of the each plinth for resting the wheels of the transformer.

b) Foundations for poles: These shall be provided to each pole which will be used to receive the power supply, mounting the A.B. switches, lightening arresters, D.O. fuses etc. The size of foundation shall 60 mm x 60 mm and 180 cm deep in 1:3:6 cement concrete & 45 cm x 45 cm plinth duly plastered with necessary curing etc. in a neat manner.

Cable Trenches

Necessary cable trenches shall be constructed from each transformer to the pump house.

The trench shall be at least .7m deep and of suitable with depending upon the no of cables to be used through and layer of .2m shall be provided at the bottom on trench and bricks shall be placed on both side of the cable.

Suitably designed markers shall be provided and fixed at every 3-4 meters showing the cable path. The earth in trench shall be filled with crown form at the top.

First aid kit shall be kept in the near by room immediate half to the injured person in case of accident.

9. RISING AND DISTRIBUTION MAINS

Centrifugally cast iron or ductile iron spun pipe shall be used for laying Rising and Distribution Mains as shown in drawing. Centrifugally cast iron spun pipe (LA-Class) conforming to IS 5382-1969 and ductile iron (class K-7/K-9) confirming IS 8329:2000 shall be used requisite number of CI Sluice valves and Scour valves will be provided on the mains. Necessary chambers for valves as per type design shall be constructed. Necessary CI Specials conforming to ISS:- 1538-1969 or DI specials confirming to IS 9523:2000; pig lead conforming to ISS:- 782-1978,yarn conforming to ISS:- 6587-1972 will be supplied and fixed by the contractor and making lead caulked joints or push on joints with rubber gasket as per IS Specification and direction. Thrust blocks will also be provided at places like bends and wherever directed. **The successful tenderer will have to get pipes, pumps, motor, transformers etc inspected by DGSD/SGS/RITS/BIS before dispatch to site at their own cost and will submit inspection report to consignee accordingly**. The materials will be accepted by the consignee after proper verification at the consignee end

The pipes shall be tyton jointed. Rubber gaskets conforming to IS 5382-1969 shall be used for tyton joints.

Laying of CI/DI pipes shall be as per IS 12288:1987. The width of trench at top and bottom, between faces of sheeting shall be such as to provide minimum 30 cms clearance on either side of the pipe for pipe diameters less than 600 mm and 45 cms for pipe diameters 600 mm and above.

Before laying of pipe the bottom of trench shall be trimmed off to present a plain surface and all irregularities shall be leveled. Where large stone or boulders or rock is met in excavation, murum or sand bedding of 10 cms thick shall be provided below pipe. All care should be taken to protect the pipe and the coating.

10. Excavation in average soil, soft and hard murum, concrete boulders etc.

a) General: The trench shall be so dug that the pipe may be laid to the required alignment, at the required grade and depth

b) As per direction of the Engineer in charge. The depth of the trench should be sufficient to have a minimum cover of 100 cms. In cases where this is not feasible a decision in this regard shall be taken as directed by Engineer in charge. The trench shall be excavated only so far in advance of pipe laying as per the orders of the Engineer in charge. The trench shall be so braced and drained that the workmen may work there in safely and there shall be no danger to the nearby structures. If any stems and roots of trees are encountered in the excavation of trenches these will have to be cut and destroyed under the supervision and direction of Engineer in charge. If water lines, drainage lines, Electric or Telephone cables are encountered in the excavation of

trenches, the work of excavation or laying of line etc. will have to be carried out without damaging the lines and cables and under the supervision of the concerned staff. Appropriate clearances shall be kept from the existing utilities as directed by Engineer in charge. Extra claim for dewatering will not be entertained.

c) Barricades, guards and safety provisions: To protect from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards as required shall be placed and maintained during the progress of the work and until it is safe for traffic to use the road ways. All material, pipe equipment and pipes which may serve as obstructions to traffic shall be enclosed by fences or barricades and shall be protected by proper lights when visibility is poor.

d) Maintenance of traffic and closing streets: The work shall be carried in such a manner which will cause the least interruption to traffic, and the road street may be closed in such a manner that it causes the least interruption to the traffic. Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that the work is under progress or a street is closed etc. shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

e) Structure Protection: Temporary support, adequate protection and maintenance of all underground and surface structure drains, sewers cables and other obstructions encountered in the progress of the work shall be furnished under the direction of Engineer in charge.

Refilling of Trenches.

a) General: The refilling of trenches shall be carried out immediately after the Flow test is over. Refilling shall be done for 25 cms above the ground level and then it shall be thoroughly wetted and properly compacted with a mechanical earth rammer so that mud etc. shall not be formed.

i) Clearing up the site: All surplus material and all tools and temporary structures shall be removed from the site as directed by Engineer in charge. All dirt, rubbish and excess earth from the excavation shall be hauled to a dump and the work site left clean to the satisfaction of the Engineer in charge. The item includes bailing out water manually or by dewatering pump sets. The pumped water shall be carefully disposed off in nearby nalla etc. without causing any damage or inconvenience to neighboring existing structures and property holders.

1. Excavation in soft rock, dewatering, refilling etc. as above.

2. Excavation in hard rock by chiseling, refilling etc. as above. Specifications are the same as above except that the excavation will have to be carried out in hard rock. The excavation in hard rock is to be carried out by chiseling or any other method (This includes excavation done by poclain, Splitter or any other mechanical means) to the required width and depth. Other specifications are the same as above. Blasting will not be allowed in the work. Extra claim for dewatering will not be entertained.

GENERAL

Soil testing reports of the recognized institute must be submitted by the tenderer before start of the work at own cost. The design must be on the basis of soil testing report. The design shall be in accordance with various relevant I.S. specifications (I.S. 456-2000, I.S. 875-1987, I.S. 3370-1965, I.S.432 part-1, I.S. 1786, I.S. 1139)

The design shall satisfy the stipulations as per I.S. 1893-1984 and I.S. 13920-1995 for seismic forces and I.S. 11682-1985 for RCC staging of overhead water tank.

Plain round M.S. bar grade-I conforming to I.S. 432 part –1 or high yield strength deformed bars I.S. 1786 of 1139 shall be used. Grade II M.S. bars shall not be used.

Entire structure shall be as per latest IS specifications.

19 cm thick cement plaster (1:3) with 5% water proofing compound of approved quality shall be provided over the bottom floor and inside surface of tank wall. 12 mm thick cement plaster (1:4) shall be provided over the exposed surface of columns, beams, bracings, bottom dome and tank wall outside surface etc. 12 mm thick cement plaster (1:6) shall be provided for the inside and outside surface of rooms.

Three coats of exterior painting over a coat of cement primer shall be provided in the water tower. Irrespective of the foundation proposed in the design, one set of bracing be provided at the ground level. The scope of pipe assembly work shall be up to 5 meter beyond the out side face of the wall including the cost of pipes, valves and specials including laying and jointing.

The job includes designing the structure for uplift pressure and dewatering if required during entire execution and disposal of surplus excavated stuff within a lead of 50 meter as directed by the Engineer in charge.

C.I. D/F pipe be as per relevant I.S. standard shall be used for rising, delivery, overflow and washout main of the water tower.

R.C.C roof shall be constructed at the level of first and second bracing under which rooms shall be constructed by 250 mm thick brick masonry walls for key man and operational staff or office accommodation with Toilet including W.C. Septic tank Soak pit and necessary electrification. Sufficient number of doors and windows shall be provided in the rooms.

Provision shall be made for spiral RCC stairs from outside of staging with 25 mm G.I. pipe railing on both sides for going in the tank.

Spacing between two braces should not be more than 3m C/C.

Provision shall be made for cylindrical ventilator fitted with mosquito proof net and two manholes with M.S. frame and cover with locking Arrangements of adequate size both in the roof slab as well as top dome.

Provision shall be made for lightening conductor as per I.E. rules

Provision shall be made for M.S. water level indicator with 450 mm diameter copper ball etc.

Part rate shall be payable for reinforcement concrete and plastering item of all types of water retaining structure till satisfactory hydraulic testing for water tightness test is given and till that work shall be treated as incomplete.

The Design and Drawing of the water Tower/underground service reservoir shall be vetted by NIT, Patna or any other NIT/IIT, for which no payment will be done by BRJP. The bidder has to bear the cost.

VALVES

A) Sluice Valve

The valves shall be as per IS and of standard required size

The manufacturers test certificate for the material shall be provided at the time of the testing. Required supports to the valves in C.C. shall be provided.

The dimensional drawing shall be submitted by the contractor prior to manufacture showing all the construction details etc. of valve for approval. The valves shall be painted after testing as directed by the Engineer in charge.

Kinetic Air Valve

These shall be as per IS and of standard required size. The air valve shall be designed to operate satisfactorily at normal working pressure of 10 kgf/cm2 Kinetic air valve body shall be tested for 10 kg/cm2. Air valve shall be provided with isolating sluice valve, which shall generally comply IS applicable to sluice valve.

C) VALVE CHAMBERS

The valve chambers should be constructed for protection of valves from traffic load to avoid damage by people. The valves should be constructed as per the type design drawings. The construction of the chamber should be in R.C.C and should be able to withstand the superimposed load due to vehicular traffic. The top of the chamber should be covered by RCC pre cast slabs. All the civil work should be as per the general specification mentioned earlier and as per applicable I.S. standards.

SECTION 7
BILL OF QUANTITY

(Rates to be quoted in Financial Bid Sheet attached separately)

BILL OF QUANTITIES

Preamble

1. **The Bill of Quantities shall be read in conjunction with the Instructions to Bidders, Conditions of Contract, Technical Specifications and Drawings.**

2. **The quantities given in the Bill of Quantities are estimated and provisional and are given to provide a common basis for bidding. The basis of payment will be the actual quantities of work ordered and carried out, as measured by the Contractor and verified by the Engineer and valued at the rates and prices tendered in the priced Bill of Quantities, where applicable, and otherwise at such rates and prices as the Engineer may fix within the terms of the Contract.**

3. **The rates and prices tendered in the priced Bill of Quantities shall, except in so far as it is otherwise provided under the Contract, include all constructional plant, labour supervision, materials, erection, maintenance, insurance, profit, taxes and duties, together with all general risks, liabilities and obligations set out or implied in the Contract.**

4. **The rates and prices shall be quoted entirely in Indian Currency.**

5. **A rate whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Bill of Quantities, and where no Items are provided the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.**

6. **The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Bill of Quantities, and where no Items are provided the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.**

7. **General directions and descriptions of work and materials are not necessarily repeated or summarized in the Bill of Quantities. References to the relevant sections of the contract documentation shall be made before entering rates or prices against each item in the Bill of Quantities.**

8. **The method of measurement of completed work for payment shall be in accordance with the specification issued by the department time to time.**

9. **Errors will be corrected by BUIDCo for any arithmetic errors pursuant to Clause 29 of the Instructions to Bidders.**

BILL OF QUANTITIES

Sl. No.	Description of Item (with brief specification and reference to book of specification)	Quantity	Unit	Rate		Amount
				In Figure	In Words	
	Attached					

Note :

1. **Item for which no rate or price has been entered in will not be paid for by BUIDCo when executed and shall be deemed covered by the other rates and prices in the bill of quantities**

2. **Unit rates and prices shall be quoted by the bidder in Indian rupee**

3. **Where there is a discrepancy between the rate in figures and words, the rates in words will govern.**

4. **Where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by quantity, the unit rate quoted shall govern**

BREAK UP SCHEDULE FOR PAYMENT

All the payments shall be paid as per the actual quantities as mentioned in the BOQ.

In all rooms, accommodation and related works electric, water supply and sanitation facility should be provided as required and as per direction of E/I without any extra cost to the department.

All essential / minor items which have not been mentioned in schedule of quantities but required to be completed for efficient working should be done as per direction of E/I without any extra cost. These items are deemed to be covered under different items which has been mentioned in schedule of quantities

SECTION 8

SECURITIES AND OTHER FORMS

(to be filled by Bidder/Employer)

TECHNICAL BID SHEET

(To be filled in Technical Bid Sheet attached separately)

BID SECURITY (BANK GUARANTEE UNCONDITIONAL)

WHEREAS, _____[name of Bidder] (hereinafter called "the Bidder") has submitted his Bid dated _____[date] for the construction of _____[name of Contract 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 BUIDCo. Ltd. (hereinafter called "the Employer") in the sum of _____ _____*for which payment well and truly to be made to the said Employer by 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 this obligation 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 having been notified to 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 refuses to furnish the Performance Security, in accordance with the Instruction to Bidders; or

(c) Does not accept the correction of the Bid Price pursuant to Clause 27.

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 as due to him owing to the occurrence of one or any of the three conditions, (specifying the occurred condition or conditions).

This Guarantee will remain in force up to and including the date _____ days after the deadline for submission of Bids as such 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 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 BANK GUARANTEE

To

_____ [name of Employer]

_____ [address of Employer]

_____

WHEREAS _____ [name and address of Contractor] (hereafter called "the Contractor") has undertaken, in pursuance of Contract No. _____ dated _____ 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 Contractor 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 the types and proportions of currencies in which the Contract Price 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 us with the demand.

We further agree that no change or addition to or other modification of the terms of the Contract or of the Works to be performed there under 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 change, addition or modification.

This guarantee shall be valid until 28 days from the date of expiry of the Defect Liability 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 including additional security for unbalanced Bids, if any and denominated in Indian Rupees.***

UNCONDITIONAL 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 to 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 modification of the terms of the Contractor or Works to be performed there under or 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 modification.

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.

Yours truly,

Signature and Seal :_____

Name of Bank /Financial Institution_____

Address : _____

Date : _____

***** ***An amount shall be inserted by the Bank or Financial Institution representing the amount of the Advance Payment, and denominated in Indian Rupees.***

INDENTURE FOR SECURED ADVANCES

FORM 31

(for use in case in which the contract is for finished work and the contractor has entered into an agreement for the execution of a certain specified quantity of work in a given time)

This indenture made the _____ day of _____, 20_____ BETWEEN _____ (hereinafter called the contractor which expression shall where the context so admits or implies be deemed to include his executors, administrators and assigns) or the one part and the Employer of the other part.

Whereas by an agreement dated _____ (hereinafter called the said agreement) the contractor has agreed.

AND WHEREAS the contractor has applied to the Employer that he may be allowed advance on the security of materials absolutely belonging to him and brought by him to the site of the works the subject of the said agreement for use in the construction of such of the works as he has undertaken to execute at rates fixed for the finished work (inclusive of the cost of materials and labour and other charges)

AND WHEREAS the Employer has agreed to advance to the Contractor the sum of Rupees_____ on the security of materials the quantities and other particulars of which are detailed in Accounts of Secured Advances attached to the Running Account bill for the said works signed by the Contractor on_____ and the Employer has reserved to himself the option of making any further advance or advances on the security of other materials brought by the Contractor to the site of the said works.

Now THIS INDENTURE WITNESSETH that in pursuance of the said agreement and in consideration of the sum of Rupees _____ on or before the execution of these presents paid to the Contractor by the Employer (the receipt where of the Contractor doth hereby acknowledge) and of such further advances (if any) as may be made to him as a for said the Contractor doth hereby covenant and agree with the President and declare as follows :

(1) That the said sum of Rupees _____ so advanced by the Employer to the Contractor as aforesaid and all or any further sum of sums advanced as aforesaid shall be employed by the Contractor in or towards expending the execution of the said works and for no other purpose whatsoever.

(2) That the materials details in the said Account of Secured Advances which have been offered to and accepted by the Employer as security are absolutely the Contractor's own propriety and free from encumbrances of any kind and the contractor will not make any application for or receive a further advance on the security of materials which are not absolutely his own property and free from encumbrances of any kind and the Contractor indemnified the Employer against all claims to any materials in respect of which an advance has be made to him as aforesaid.

(3) That the materials detailed in the said account of Secured Advances and all other materials on the security of which any further advance or advances may hereafter be made as aforesaid (hereafter called the said materials) shall be used by the Contractor solely in the Execution of the said works in accordance with the directions of the Engineer.

(4) That the Contractor shall make at his own cost all necessary and adequate arrangements for the proper watch, safe custody and protection against all risks of the said materials and that until used in construction as aforesaid the said materials shall remain at the site of the said works in the Contractor's custody and on his own responsibility and shall at all times be open to inspection by the Engineer or any officer authorized by him. In the event of the said materials or any part thereof being stolen, destroyed or damaged or becoming deteriorated in a greater degree than is due to reasonable use and wear thereof the Contractor will forthwith replace the same with other materials of like quality or repair and make good the same required by the Engineer.

(5) That the said materials shall not be any account be removed from the site of the said works except with the written permission of the Engineer or an officer authorized by him on that behalf.

(6) That the advances shall be repayable in full when or before the Contractor receives payment from the Employer of the price payable to him for the said works under the terms and provisions of the said agreement. Provided that if any intermediate payments are made to the Contractor on account of work done than on the occasion of each such payment the Employer will be at liberty to made recovery from the Contractor's bill for such payment by deducting there from the value of the said materials that actually used in the construction and in respect of which recovery has not been made previously, the value for this purpose being determined in respect of each description of materials at the rates at which the amounts of the advances made under these presents were calculated.

(7) That if the Contractor shall at any time make any default in the performance or observance in any respect of any of the terms and provisions of the said agreement or of these presents the total amount of the advance or advances that may still be owing of the Employer shall immediately on the happening of such default be repayable by the Contractor to be the Employer together with interest thereon at twelve per cent per annum from the date or respective dates of such advance or advances to the date of repayment and with all costs, charges, damages and expenses incurred by the Employer in or for the recovery thereof or the enforcement of this security or otherwise by reason of the default of the Contractor and the Contractor hereby covenants and agrees with the Employer to reply and pay the same respectively to him accordingly.

(8) That the Contractor hereby charges all the said materials with the repayment to the Employer of the said sum of Rupees _____ _____ and any further sum of sums advanced as aforesaid and all costs, charges, damages and expenses payable under these presents PROVIDED ALWAYS and it is hereby agreed and declared that notwithstanding anything in the said agreement and without prejudice to the power contained therein if and whenever the covenant for payment and repayment here in before contained shall become enforceable and the money owing shall not be paid in accordance there with the Employer may at by time thereafter adopt all or any of the following courses as he may deem best :

(a) Seize and utilise the said materials or any part thereof in the completion of the said works on behalf of the contractor in accordance with the provisions in that behalf contained in the said agreement debiting the contractor with the actual cost of effecting such completion and the amount due to the contractor with the value of work done as if he has carried it out in accordance with the said agreement and at the rests thereby provided. If the balance is against the contractor, he is to pay same to the Employer on demand.

(b) Remove and sell by public auction the seized materials or any part there of and out of the moneys arising from the sale retain all the sums aforesaid repayable or payable to the Employer under these presents and pay over the surplus (if any) to the Contractor.

(c) Deduct all or any part of the moneys owing out of the security deposit or any sum due to the Contractor under the said agreement.

(9) That except in the event of such default on the part of the contractor as aforesaid interest on the said advance shall not be payable.

(10) That in the event of any conflict between the provisions of these present and the said agreement the provisions of these presents shall prevail and in the event of any dispute or difference arising over the construction or effect of these presents the settlement of which has not been here-in-before expressly provided for the same shall be referred to the Employer whose decision shall be final and the provision of the Indian Arbitration Act for the time being in force shall apply to any such reference.

Letter of Acceptance

(Letterhead paper of BUIDCo)

_____(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[1] is hereby accepted by our agency.

We accept/ do not accept that _____ be appointed as the Adjudicator[2]. Your are hereby requested to furnish Performance Security, in the form detailed in Para 31.1 of ITB for an amount equivalent to Rs. _____ within 15 days of the receipt of this letter of acceptance valid up to 28 days from the date of expiry of defects Liability Period i.e. up to _____ and sign the contract, failing which action as stated in Para 31.3 of ITB will be taken.

Yours faithfully,

Authorized Signature

Name and title of Signatory

Name of Agency

---

[1] ***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.***

[2] ***To be used only if the Contractor disagrees in his Bid with the Adjudicator proposed by the Employer in the "Instructions to Bidders".***

Issue of Notice to proceed with the work

(Letterhead of BUIDCo)

_____(Date)

To

_____(Name and address of the Contractor)

_____

_____

Dear Sirs,

Pursuant to your furnishing the requisite security as stipulated 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 ob behalf of Employer)

Agreement Form

Agreement

This agreement, made the _____ day of _____ between _____(name and address of Employer) [hereinafter called "the (name and address of contractor) hereinafter called "the Contractor" of the other part.]

Whereas BUIDCo is desirous that the Contractor execute

_____

(name and identification number of Contract) (hereinafter called "the Works") and BUIDCo 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 and construed as part of this Agreement.

2. In consideration of the payments to be made by BUIDCo to the Contractor as hereinafter mentioned, the Contractor hereby covenants with BUIDCo to execute and complete the Works and remedy any defects therein in conformity in all aspects with the provisions of the contract.

3. BUIDCo 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) Condition of Contract : General and Special**
- **(v) Contract Data**
- **(vi) Additional condition**
- **(vii) Drawings**
- **(viii) Bill of Quantities and**
- **(ix) Any other documents listed in the Contract Data as forming part of the Contract.**

In witnessed 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

I, the undersigned do hereby undertake that our firm M/s _____ _____ agree to abide by this bid for a period _____ days for the 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 Authorised Officer of the Firm)

_____

Title of Officer

_____

Name of Firm

_____

DATE

VOLUME - IV

SECTION 9
DRAWINGS
(To be Attached)

VOLUME - V

SECTION 10
DOCUMENTS TO BE FURNISHED BY BIDDER)
(Attached)