UDAIPUR SMART CITY LIMITED

Municipal Corporation, Udaipur, Town Hall, Udaipur
Tel: 0294-2421255 ; Fax: 0294-2421255
Website:www. udaipursmartcity.in, **E-mail:** mc_udaipur@rediffmail.com

International Competitive Bidding

Notice Inviting E-Tender 07 / 2017-18

Nit No.: USCL/dev{ }/2017-18/07 Date:- 20-07-2017

The USCL invites online unconditional bids under Single Stage two envelope system through e-procurement portal http://eproc.rajasthan.gov.in from eligible bidders as per criteria mentioned in bid document, for works of Integrated Infrastructure Package for ABD area, Udaipur with one year Defect Liability period and O&M of 10 years

SNo.	Name of Work	Estimated Cost (Rs. in Lacs)	Bid Security (Rs. in Lacs)	Tender Fee / Processing Fee pay to M.D. RISL, Jaipur	Period of completion	Publish date & Start date of downloading of Bid documents	Pre-bid meeting	Last date of submission of on-line bids	Last date & time of submission of depositing documents in hard copy as stated under	Date of opening of technical bids
1	Integrated Infrastructure Package for ABD area, Udaipur with one year Defect Liability period and O&M of 10 years	48,000.00	960.00	1,00,000/- 1,000/- Processing Fee	24 months	24.07.17 from 11:00 A.M.	10.08.2017 at 3:00 P.M.	11.09.17 (up to 04:00 P.M.)	12.09.17 up to 03:00 P.M.	12.09.17 at 04:00 P.M.

Earnest money and cost of tender documents shall be deposited through RTGS/ NEFT in the account of Smart City Udaipur having account no. 004994600000301 with YES Bank, Ground & First floor, "Goverdhan Plaza" 29 N.N. Acharya Marg, Udaipur branch (IFSC code YESB0CMSNOC). The unique transaction reference of RTGS/ NEFT shall be uploaded by the tenderer along with scanned copies of eligibility documents with "Eligibility Bid". The financial bid shall be submitted online only. Hard copies of documents related to eligibility bid and UTR of EMD/ cost of tender documents shall however also be submitted to USCL, Municipal Corporation Udaipur, Town Hall Udaipur by 12.09.17. The pre-bid meeting will be held on as above at conference hall, USCL Municipal Corporation Udaipur, Town Hall Udaipur. The tender will be uploaded till 11.9.2017 up to 4.00 P.M. The financial bid of tenderers qualifying eligibility criteria shall thereafter be opened on specific time, date of venue which will be intimated to them separately. The provisions of RTPP Act 2012 and Rules 2013 thereto shall be applicable for this procurement. Furthermore, in case of any inconsistency in any of the provisions of this bidding document with the RTPP Act 2012 and Rules thereto, the latter shall prevail.

Websites for downloading Bidding Document sppp.rajasthan.gov.in & eproc.rajasthan.gov.in

Chief Executive Officer
Udaipur Smart City Limited

प्रतिलिपी :–

1. प्रबन्ध निदेशक, राजस्थान सम्वाद, सूचना एवं जन सम्पर्क विभाग परिसर, शासन सचिवालय, जयपुर को प्रेषित कर निवेदन है कि उपरोक्त निविदा का प्रकाशन **राजस्थान** लोक उपापन में पारदर्शिता नियम 2013 के अनुसार प्रकाशन कराने का कष्ट करें।

   (i) एक मुख्य **क्षैत्रीय** दैनिक समाचार पत्र, पचास हजार प्रतियां या इससे अधिक के परिचालन **वाले एक राज्य स्तरीय मुख्य दैनिक समाचार पत्र।**

   (ii) **वृहत् परिचालन वाला एक अखिल भारतीय स्तर का दैनिक समाचार पत्र** में प्रकाशित कराने का श्रम करावें।

2. नोटिस बोर्ड पर चस्पा हेतु।

Chief Executive Officer
Udaipur Smart City Limited

UDAIPUR SMART CITY LIMITED

Telephone: 0294-2421255, Email: mc_udaipur@rediffmail.com

DETAILED NOTICE INVITING BID (NIB)

NIT No: E-7 / 2017-18

Udaipur Smart City Limited invites online unconditional tenders under Single Stage two envelope system are invited through e-procurement portal http://eproc.rajasthan.gov.infrom eligible bidders as per criteria mentioned in bid document, for Integrated Infrastructure Package for ABD area, Udaipur with one year Defect Liability period and O&M of 10 years-

Name & Address of the Procuring Entity	Name: **Sidharth Sihag, Chief Executive Officer** Address: Udaipur Smart City Limited, Udaipur
Subject Matter of Procurement	Integrated Ifrastructure Package for ABD area, Udaipur with one year Defect Liability period and O&M of 10 years
Period of completion of physical works	24 months
Bid Procedure	Single-stage: Two Part (envelope) open competitive eBid procedure at http://eproc.rajasthan.gov.in
Bid Evaluation Criteria (Selection Method)	Least Cost based selection
Eligibility Criteria	As detailed in bid documents
Websites for downloading Bidding Document	sppp.rajasthan.gov.in eproc.rajasthan.gov.in

Fees	Bidding document fee (Non-Refundable): Rs. 100000/- (Rupees One Lac only) in Cash/Demand Draft drawn on any Scheduled/ Commercial Bank in favour of "**Chief Executive Officer**, Udaipur Smart City Limited" payable at "Udaipur". Tender Processing Fee (Non-Refundable): Rs. 1000 (Rupees One Thousand only) in Demand Draft drawn on any Scheduled/ Commercial Bank in favour of "Managing Director, RISL" payable at "Jaipur"
Estimated Procurement Cost	Rupees Four Hundred Eighty Crores (INR 4,80,00,00,000)
Bid Security and Mode of Payment	Amount: INR 9,60,00,000/- (Rupees Nine crore sixty lakhs Only) Mode of Payment: Banker's Cheque/Demand Draft drawn on any Scheduled Commercial Bank or Bank Guarantee as per Bid document.

Period of on-line availability of Bidding Documents (Start / End Date)	From: 24.07.2017, 11.00 AM onwards till 03:00 PM of 11.09.2017
Pre-bid Meeting	Date/ Time 10.08.17 at 3:00 PM Place: Udaipur Smart City Limited, Udaipur
Manner, End Date for submission of Bids	Manner: Online at eProc website (http://eproc.rajasthan.gov.in) End Date: 11.09.17 (up to 04:00 P.M.)
Submission of original Banker's Cheque/ Demand Draft for Bid Document cost, Bid Security, Bid Processing Fee & other documents listed herein after	12.09.17 till 03:00 PM
Date & Time of Technical Bid Opening	Date: 12.09.17 Time: 04:00 PM
Date/ Time/ Place of Financial Bid Opening	Will be intimated later to the Technically qualified bidders
Bid Validity	180 days from the bid submission deadline
Note:	

1) Bidders (authorised signatory) shall submit their offer on-line in Electronic formats both for technical and financial proposal. However, DD / Banker's Cheques / BG (if applicable) for RFP Document Fees, RISL Processing Fees and Bid Security should be submitted physically in original at the office of Udaipur Smart City Limited, Udaipur by time and date mentioned above as prescribed in bid document and scanned copy of same should also be uploaded along with the technical Bid/ cover.

2) Any subsequent addendum/corrigendum shall be published only at the websites sppp.raj.nic.in & http://eproc.rajasthan.gov.in and will not be published in newspapers. In case there is a holiday on the day of opening of bids, activities assigned on that date shall be carried out on the next working day.

3) Before electronically submitting the bids, it should be ensured that all the bid documents including conditions of contract are digitally signed by the bidder.

4) Department will not be responsible for delay in online submission due to any reason. For this, bidders are requested to upload the complete bid well advance in time so as to avoid 11th hour issues like slow speed; choking of web site due to heavy load or any other unforeseen problems.

5) All the prospective bidders are encouraged to participate in the pre-bid meeting and it is advised that the work sites are visited and bid documents are studied thoroughly.
6) The procuring entity reserves the sole right to cancel the bid process and reject any or all of the Bids without assigning any reason.
7) Procurement entity disclaims any factual/ or other errors in the bidding document (the onus is purely on the individual bidders to verify such information) and the information provided therein are intended only to help the bidders to prepare a logical bid-proposal.
8) No conditional bids shall be accepted and such bids shall be summarily rejected forthwith.
9) The provisions of RTPP Act 2012 and Rules 2013 thereto shall be applicable for this procurement. Furthermore, in case of any inconsistency in any of the provisions of this bidding document with the RTPP Act 2012 and Rules thereto, the latter shall prevail.

(**Sidharth Sihag**) IAS

Chief Executive Officer

Udaipur Smart City Limited

International Competitive Bidding (Single stage two parts)

for

Udaipur Integrated Infrastructure Project

Request For Proposal

Design, Build & Operate following projects in city of Udaipur, Rajasthan:

(i) Design, Rehabilitation, Up-gradation and Construction of water distribution network and domestic 24X7water supply in ABD area of Udaipur city;
(ii) Design, Rehabilitation, Up-gradation and Construction of sewerage network in ABD area;
(iii) Design, Undergrounding of power, telecom and other cables along with Rehabilitation, Up-gradation and Construction of power distribution network and domestic connections across core area of Udaipur city;
(iv) Design and Construction of Utility duct across core area of Udaipur city; and
(v) Design and Relaying of Roads &Storm Water System in ABD area of Udaipur City.
(vi) Design, Provision, Installation of Supervisory Control and Data Acquisition (SCADA) system

Duration: 2 years

BID No: USCL/ E-7/ 2017-18

July, 2017

Chief Executive Officer
Udaipur Smart City Limited, Udaipur

Bidding Document

Table of Contents

UDAIPUR SMART CITY LIMITED

Telephone: 0294-2421255, Email: mc_udaipur@rediffmail.com

DETAILED NOTICE INVITING BID (NIB)

NIT No: E-7 / 2017-18

Udaipur Smart City Limited invites online unconditional tenders under Single Stage two envelope system are invited through e-procurement portal http://eproc.rajasthan.gov.infrom eligible bidders as per criteria mentioned in bid document, for Integrated Infrastructure Package for ABD area, Udaipur with one year Defect Liability period and O&M of 10 years-

Name & Address of the Procuring Entity	Name: **Sidharth Sihag, Chief Executive Officer** Address: Udaipur Smart City Limited, Udaipur
Subject Matter of Procurement	Integrated Ifrastructure Package for ABD area, Udaipur with one year Defect Liability period and O&M of 10 years
Period of completion of physical works	24 months
Bid Procedure	Single-stage: Two Part (envelope) open competitive eBid procedure at http://eproc.rajasthan.gov.in
Bid Evaluation Criteria (Selection Method)	Least Cost based selection
Eligibility Criteria	As detailed in bid documents
Websites for downloading Bidding Document	sppp.rajasthan.gov.in eproc.rajasthan.gov.in

Fees	Bidding document fee (Non-Refundable): Rs. 100000/- (Rupees One Lac only) in Cash/Demand Draft drawn on any Scheduled/ Commercial Bank in favour of "**Chief Executive Officer**, Udaipur Smart City Limited" payable at "Udaipur". Tender Processing Fee (Non-Refundable): Rs. 1000 (Rupees One Thousand only) in Demand Draft drawn on any Scheduled/ Commercial Bank in favour of "Managing Director, RISL" payable at "Jaipur"
Estimated Procurement Cost	Rupees Four Hundred Eighty Crores (INR 4,80,00,00,000)
Bid Security and Mode of Payment	Amount: INR 9,60,00,000/- (Rupees Nine crore sixty lakhs Only) Mode of Payment: Banker's Cheque/Demand Draft drawn on any Scheduled Commercial Bank or Bank Guarantee as per Bid document.

Period of on-line availability of Bidding Documents (Start / End Date)	From: 24.07.2017, 11.00 AM onwards till 03:00 PM of 11.09.2017
Pre-bid Meeting	Date/ Time 10.08.17 at 3:00 PM Place: Udaipur Smart City Limited, Udaipur
Manner, End Date for submission of Bids	Manner: Online at eProc website (http://eproc.rajasthan.gov.in) End Date: 11.09.17 (up to 04:00 P.M.)
Submission of original Banker's Cheque/ Demand Draft for Bid Document cost, Bid Security, Bid Processing Fee & other documents listed herein after	12.09.17 till 03:00 PM
Date & Time of Technical Bid Opening	Date: 12.09.17 Time: 04:00 PM
Date/ Time/ Place of Financial Bid Opening	Will be intimated later to the Technically qualified bidders
Bid Validity	180 days from the bid submission deadline
Note:	

1) Bidders (authorised signatory) shall submit their offer on-line in Electronic formats both for technical and financial proposal. However, DD / Banker's Cheques / BG (if applicable) for RFP Document Fees, RISL Processing Fees and Bid Security should be submitted physically in original at the office of Udaipur Smart City Limited, Udaipur by time and date mentioned above as prescribed in bid document and scanned copy of same should also be uploaded along with the technical Bid/ cover.

2) Any subsequent addendum/corrigendum shall be published only at the websites sppp.raj.nic.in & http://eproc.rajasthan.gov.in and will not be published in newspapers. In case there is a holiday on the day of opening of bids, activities assigned on that date shall be carried out on the next working day.

3) Before electronically submitting the bids, it should be ensured that all the bid documents including conditions of contract are digitally signed by the bidder.

4) Department will not be responsible for delay in online submission due to any reason. For this, bidders are requested to upload the complete bid well advance in time so as to avoid 11th hour issues like slow speed; choking of web site due to heavy load or any other unforeseen problems.

5) All the prospective bidders are encouraged to participate in the pre-bid meeting and it is advised that the work sites are visited and bid documents are studied thoroughly.
6) The procuring entity reserves the sole right to cancel the bid process and reject any or all of the Bids without assigning any reason.
7) Procurement entity disclaims any factual/ or other errors in the bidding document (the onus is purely on the individual bidders to verify such information) and the information provided therein are intended only to help the bidders to prepare a logical bid-proposal.
8) No conditional bids shall be accepted and such bids shall be summarily rejected forthwith.
9) The provisions of RTPP Act 2012 and Rules 2013 thereto shall be applicable for this procurement. Furthermore, in case of any inconsistency in any of the provisions of this bidding document with the RTPP Act 2012 and Rules thereto, the latter shall prevail.

(**Sidharth Sihag**) IAS

Chief Executive Officer

Section-I : Instructions to Bidders

INSTRUCTION TO BIDDERS

Important Instruction:- The Law relating to procurement "The Rajasthan Transparency in Public Procurement Act, 2012" [hereinafter called the Act] and the "Rajasthan Public Procurement Rules, 2012" [hereinafter called the Rules] under the said Act have come into force which are available on the website of State Public Procurement Portal http://sppp.raj.nic.in. Therefore, the Bidders are advised to acquaint themselves with the provisions of the Act and the Rules before participating in the Bidding process. If there is any discrepancy between the provisions of the Act and the Rules and this Bidding Document, the provisions of the Law shall prevail.

1. General			
1.1	Scope of Bid	1.1.1	In support of the Invitation to Bid indicated in the Bid Data Sheet (BDS), the Procuring Entity as indicated in the BDS, issues this Bidding Document for the procurement of works as named in the BDS and as specified in Section V, Procuring Entity's Requirements.
1.2	Interpretation	1.2.1	Throughout this Bidding Document: the term "in writing" means communicated in written form through letter, fax, e-mail etc. with proof of receipt. If the context so requires, singular means plural and vice versa; and "Day" means calendar day
1.3	Code of Integrity	1.3.1	Any person participating in the procurement process shall,- i. not offer any bribe, reward or gift or any material benefit either directly or indirectly in exchange for an unfair advantage in procurement process or to otherwise influence the procurement process; ii. not misrepresent or omit that misleads or attempts to mislead so as to obtain a financial or other benefit or avoid an obligation; iii. not indulge in any collusion, bid rigging or anti-competitive behavior to impair the transparency, fairness and progress of the procurement process; iv. not misuse any information shared between the Procuring Entity and the Bidders with an intent to gain unfair advantage in the procurement process; v. not indulge in any coercion including impairing or harming or threatening to do the same, directly or indirectly, to any party or to its property to influence the procurement process; vi. not obstruct any investigation or audit of a procurement process; vii. disclose conflict of interest, if any; and

			viii. disclose any previous transgressions with any Entity in India or any other country during the last three years or any debarment by any other Procuring Entity.
		1.3.2	Conflict of Interest: A conflict of interest is considered to be a situation in which a party has interests that could improperly influence that party's performance of official duties or responsibilities, contractual obligations, or compliance with applicable laws and regulations. A Bidder may be considered to be in conflict of interest with one or more parties in this bidding process if, including but not limited to: i. have controlling partners/ shareholders in common; or ii. receive or have received any direct or in direct subsidy from any of them ;or iii. have the same legal representative for purposes of this Bid; or iv. have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the Bid of another Bidder, or influence the decisions of the Procuring Entity regarding this bidding process; or v. the Bidder participates in more than one Bid in this bidding process. Participation by a Bidder in more than one Bid will result in the disqualification of all Bids in which the Bidder is involved. However, this does not limit the inclusion of the same subcontractor, not otherwise participating as a Bidder, in more than one Bid; or vi. the Bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the Works that are the subject of the Bid; or vii. the Bidder or any of its affiliates has been hired (or is proposed to be hired) by the Procuring Entity as Engineer-in-charge/ consultant for the Contract.
		1.3.3	The Bidder shall have to give a declaration regarding compliance of the Code of Integrity prescribed in the Act, the Rules and stated above in this Clause along with its Bid, in the format specified in Section IV, Bidding Forms.
		1.3.4	Breach of Code of Integrity by the Bidder:- Without prejudice to the provisions of Chapter IV of the Rajasthan Transparency in Public Procurement Act, in

			case of any breach of the Code of Integrity by a Bidder or prospective Bidder, as the case may be, the Procuring Entity may take appropriate action in accordance with the provisions of sub-section (3) of section 11 and section 46 of the Act.
1.4	Eligible Bidders	1.4.1	A Bidder may be a natural person, private Entity, government-owned Entity or, where permitted in the Bidding documents, any combination of them with a formal intent to enter into an agreement or under an existing agreement in the form of a Joint Venture [JV], and / or Consortium / Association. In the case of a Joint Venture, Consortium / Association:- all parties to the Joint Venture, Consortium / Association shall sign the Bid and they shall be jointly and severally liable; and a Joint Venture, Consortium / Association shall nominate a representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the Joint Venture, Consortium or Association during the Bidding process. In the event the Bid of Joint Venture, Consortium / Association is accepted, either they shall form a registered Joint Venture or Consortium / Association will have to be legalized, or otherwise all the parties to Joint Venture, Consortium / Association shall sign the Agreement.
		1.4.2	A Bidder, and all parties constituting the Bidder, shall have the nationality of India. In case of International Competitive Bidding or Joint Venture, Consortium or Association [where permitted], the nationality of the Bidder and all parties constituting the Bidder shall be of India or an eligible country declared as such by Government of India. A Bidder shall be deemed to have nationality of a country if the Bidder is a citizen or constituted or incorporated, and operates in conformity with the provisions of the Laws of that country. This criterion shall also apply to the determination of the nationality of proposed Sub-Contractors or suppliers for any part of the Contract including related services.
		1.4.3	A Bidder should not have a conflict of interest in the procurement in question as stated in the Rule 81 and this Bidding document.
		1.4.4	A Bidder debarred under section 46 of the Act shall not be eligible to participate in any procurement process undertaken by any Procuring Entity, if debarred by the State Government; and a Procuring Entity, if debarred by such Procuring Entity.

		1.4.5	The Bidder must be a registered Contractor in appropriate class with the Department/ Organization. He shall furnish necessary proof for the same.PSU can be participate in tender without registration.
		1.4.6	i Any change in the constitution of the firm, etc., shall be notified forth with by the Bidder in writing to the Procuring Entity and such change shall not relieve any former partner/ member of the firm, etc from any liability under the Contract. ii No new partner/partners shall be accepted in the firm by the Bidder in respect of the contract unless he/they agree to abide by all its terms, conditions and deposit with the Procuring Entity a written agreement to this effect. The Bidder's receipt for acknowledgement or that of any partners subsequently accepted as above shall bind all of them and will be sufficient discharge for any of the purpose of the Contract. iii The status of the lead partner/ representative of the Joint Venture, Consortium or Association as a major stake holder shall not change without the consent of the Procuring Entity. New major stakeholder must agree to abide by all terms and conditions of the Contract.
		1.4.7	Bidders shall provide such evidence of their continued eligibility satisfactory to the Procuring Entity, should the Procuring Entity request.
		1.4.8	In case a prequalification or empanelment or registration process has been conducted prior to the bidding process, this bidding shall be open only to the pre-qualified, empanelled or registered Bidders.
		1.4.9	Each Bidder shall submit only one Bid except in case of alternative bids, if permitted.
		1.4.10	Bidder has to submit sales tax clearance certificate issued by the competent authority up to 30-6-2017. He is also required to provide proof of Permanent Account Number (PAN) given by Income Tax Department. Bidder should be registered as per GST rules.
2. Contents of Bidding Document			

2.1	Sections of the Bidding Document	2.1.1	The Bidding Document consists of Parts I, II and III, which include all the Sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB Clause 2.3 [Amendment of Bidding Document]. **Part I: Bidding Procedures** Section I. Instructions to Bidders (ITB) Section II. Bid Data Sheet (BDS) Section III. Evaluation and Qualification Criteria Section IV. Bidding Forms **Part II: Requirements** Section V. Procuring Entity's Requirements. **Part III: Contract** Section VI A. General Conditions of Contract [GCC] Section VI B. Special Conditions of Contract [SCC] Section VI C. Contract Forms
		2.1.2	The Invitation for Bids (NIB) issued by the Procuring Entity is also part of the Bidding Document.
		2.1.3	i. The Bidding Document shall be uploaded on the e-procurement portal, **eproc.rajsthan.gov.in** along with the Notice Inviting Bids. The complete Bidding Document shall also be placed on the State Public Procurement Portal, **sppp.rajsthan.gov.in**. The prospective Bidders may download the bidding document from these portals. The price of the Bidding Document and processing fee of e-bid shall have to be paid to the Procuring Entity in the amount and manner as specified in Bid Data Sheet and e-procurement portal.
		2.1.4	The Procuring Entity is not responsible for the completeness of the Bidding Document and its addenda, if they were not downloaded correctly from the e-procurement portal or the State Public Procurement Portal.
		2.1.5	The Bidder is expected to examine all instructions, forms, terms and specifications in the Bidding Document. Failure to furnish all information or authentic documentation required by the Bidding Document may result in the rejection of the Bid.
2.2	Clarification of Bidding Document and Pre-Bid Conference	2.2.1	The Bidder shall be deemed to have carefully examined the conditions, specifications, size, make and drawings, etc. of the Works and Related Services to be provided. If any Bidder has any doubts as to the meaning of any portion of the conditions or of the specifications, drawings etc., it shall, before submitting the Bid, refer the same to the Procuring Entity and get

			clarifications. A Bidder requiring any clarification of the Bidding Document shall contact the Procuring Entity in writing or e-mail at the Procuring Entity's address indicated in the BDS. The Procuring Entity will respond in writing or e-mail to any request for clarification, within seven days provided that such request is received no later than twenty-one (21) days prior to the deadline for submission of Bids as specified in ITB Sub-Clause 4.2.1 [Deadline for Submission of Bids]. The clarification issued, including a description of the inquiry but without identifying its source shall also be placed on the State Public Procurement Portal and should the Procuring Entity deem it necessary to amend the Bidding Document as a result of a clarification, it shall do so following the procedure under ITB Clause 2.3 [Amendment of Bidding Document] through an addendum which shall form part of the Bidding Document.
		2.2.2	The Bidder or his authorized representative is invited to attend the Pre- Bid Conference, if provided for in the BDS. The purpose of the Pre- Bid Conference will be to clarify issues and to answer questions on any matter related to this procurement that may be raised at that stage. If required, a conducted site visit may be arranged by the Procuring Entity.
		2.2.3	The Bidder is requested, to submit questions in writing, to reach the Procuring Entity not later than one week before the date of Pre-Bid Conference.
		2.2.4	Minutes of the Pre-Bid Conference, including the text of the questions raised, and the responses given, without identifying the source, will be transmitted promptly to all Bidders who attended the Pre-Bid Conference and shall also be placed on the State Public Procurement Portal and the e-procurement portal. Any modification to the Bidding Document that may become necessary as a result of the Pre-Bid Conference shall be made by the Procuring Entity exclusively through the issue of an addendum (part of Bid document) and not through the minutes of the Pre-Bid Conference.
		2.2.5	At any time prior to the deadline for submission of the Bids, the Procuring Entity, suo motto, may also amend the Bidding Document, if required, by issuing an addenda which will form part of the Bidding Document.

		2.2.6	Non-attendance at the Pre-Bid Conference will not be a cause for disqualification of a Bidder.
2.3	Amendment of Bidding Document	2.3.1	Any addendum issued shall be part of the Bidding Document and shall be uploaded on the State Public Procurement Portal and the e-procurement portal.
		2.3.2	To give prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Procuring Entity may, at its discretion, extend the deadline for the submission of the Bids, pursuant to ITB Sub-Clause 4.2 [Deadline for Submission of Bids], under due publication on the State Public Procurement Portal and the e-procurement portal and newspapers.
3. Preparation of Bids			
3.1	Cost of Bidding	3.1.1	The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Procuring Entity shall not be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.
		3.1.2	The Bidder shall furnish the scanned attested copies of following documents with its Bid:- i. Partnership Deed and valid registration certificate with the Registrar of Firms in case of Partnership Firms. Power of Attorney in favour of the partner signing/submitting the Bid, authorizing him to represent all partners of the firm. ii. VAT/ Sales Tax registration certificate and VAT/Sales Tax clearance certificate from the concerned Commercial Taxes Officer and Permanent Account Number (PAN) given by the Income Tax Department. iii. Address of residence and office, telephone numbers e-mail address in case of sole Proprietorship. iv. Certificate of Registration and Memorandum of Association issued by Registrar of Companies in case of a registered company and in case of any other statutory or registered body, certificate of incorporation or registration issued by concerned authorities. Power of attorney in favour of the person signing the Bid. v. Where permitted to bid as Joint Venture, Consortium or Association, letter of formal intent to enter in to an agreement or an existing agreement

			in the form of a Joint Venture, Consortium or Association.
3.2	Language of Bid	3.2.1	The Bid, as well as all correspondence and documents relating to the Bid exchanged by the Bidder and the Procuring Entity, shall be written in English/ Hindi or a language specified in the BDS. Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages duly accepted by the Bidder in English/ Hindi or the language specified in the BDS, in which case, for purposes of interpretation of the Bid, such translation shall govern.
3.3	Documents Comprising the Bid	3.3.1	The Bid shall comprise of two covers, one containing the Technical Bid/ Proposal and the other the Financial or Price Bid/ Proposal. One more cover containing scanned copies of proof of payment in form specified in Bid Data Sheet, of the price of Bidding Document, processing fee and Bid Security/ Bid Securing Declaration shall be enclosed separately.
		3.3.2	The Technical Bid/ Proposal shall contain the following : i. Technical Bid/ Proposal Submission Sheet and Technical Bid containing the filled up Bidding Forms and Declarations related to Technical Bid and Code of Integrity given in Section IV [Bidding Forms]; ii. proof of payment of price of Bidding Document, processing fee, Bid Security, in accordance with ITB Clause 3.10; iii. written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB Clause 3.11; iv. documentary evidence in accordance with ITB Clause 3.7 establishing the Bidder's eligibility to bid; v. documentary evidence in accordance with ITB Clause 3.8 establishing the Bidder's qualifications to perform the contract if its Bid is accepted; vi. Drawings/ designs in support of the Works to be executed; vii. the Notice Inviting Bids; viii. any other document as per the BDS; and ix. document/s considered necessary to strengthen the Bid submitted.

		3.3.3	The Financial Bid/ Price Proposal shall contain the following : Financial Bid and the applicable Price Schedules, in accordance with ITB Clauses 3.4, 3.5; Any other document required in the BDS.
3.4	Bid Submission Sheets and Price Schedules	3.4.1	The Bidder shall submit the Technical Bid and Financial Bid using the Bid Submission Sheets provided in Section IV [Bidding Forms]. These forms must be completed without any alterations to their format, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.
		3.4.2	The Bidder shall submit as part of the Financial Bid, the Price Schedules for Works, using the forms provided in Section IV [Bidding Forms].
3.5	Bid Prices	3.5.1	i. In case of Item Rate Contracts, the Bidder shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items against which no rate or price is entered by the Bidder will not be paid for by the Procuring Entity but will have to be executed and shall be deemed covered by the rates for other items and prices in the Bill of Quantities. ii. In case of Percentage Rate Contracts, combined single percentage above or below must be quoted by the Bidder for all items of the Bill of Quantities. iii. In case of Lump Sum Contracts, only Total Price which the Bidder wants to charge for the entire Works with all its contingencies in accordance with drawings and specifications shall be quoted by the Bidder. A Schedule of Rates shall be specified in the Bid Data Sheet in order to regulate the amount to be added to or deducted from the fixed sum on account of additions and alterations not covered by the Contract. Payments shall be linked to various stages of completion of the Works specified in Activity Schedule given in Bid Data Sheet.
		3.5.2	Prices quoted by the Bidder shall be fixed during the Bidder's Performance of the Contract and not subject to variation on any account, unless otherwise specified in the BDS. A Bid submitted with an adjustable price quotation shall be treated as non-responsive and shall be rejected, pursuant to ITB Clause 5.7 [Responsiveness of Bids]. However, if in accordance with the BDS, prices quoted by the Bidder shall be subject to adjustment during the performance of the Contract, a Bid submitted with a fixed price quotation

			shall not be rejected, but the adjustment shall be treated as zero.
		3.5.3	All duties, taxes and other levies payable by the Bidder under the contract, or for any other cause, shall be included in the rates and prices, and the total Bid Price submitted by the Bidder.
3.6	Currencies of Bid.	3.6.1	The unit rates and the prices shall be quoted by the Bidder entirely in Indian Rupees unless otherwise specified in BDS. All payments shall be made in Indian Rupees only, unless otherwise specified in the BDS.
3.7	Documents Establishing the Eligibility of the Bidder	3.7.1	To establish their eligibility in accordance with ITB Clause 1.4 [Eligible Bidders], Bidders shall: complete the eligibility declarations in the Bid Submission Sheet and Declaration Form included in Section IV [Bidding Forms]; if the Bidder is an existing or intended Joint Venture [JV], Consortium or Association in accordance with ITB Sub-Clause 1.4.1, shall submit a copy of the Agreement, or a letter of intent to enter into such Agreement. The respective document shall be signed by all legally authorized signatories of all the parties to the existing or intended JV, Consortium or Association as appropriate; and the existing or intended JV shall authorize an individual/ partner in one of the firms as lead partner of the JV to act and commit all the partners of JV for the Bid.
3.8	Documents Establishing the Qualifications of the Bidder	3.8.1	To establish its qualifications to perform the Contract, the Bidder shall submit as part of its Technical Proposal the documentary evidence indicated for each qualification criteria specified in Section III, [Evaluation and Qualification Criteria].
3.9	Period of Validity of Bids	3.9.1	Bids shall remain valid for 180 days or the period specified in the BDS after the Bid submission deadline date as specified by the Procuring Entity. A Bid valid for a shorter period shall be rejected by the Procuring Entity as non-responsive.
		3.9.2	In exceptional circumstances, prior to the expiration of the Bid validity period, the Procuring Entity may request Bidders to extend the period of validity of their Bids. The request and the responses shall be made in writing. The Bid Security or a Bid Securing Declaration in accordance with ITB Clause 3.10 [Bid Security] shall also be got extended for thirty days beyond the dead line of the extended validity period. A Bidder may refuse the request without forfeiting its Bid Security or

			a Bid Securing Declaration. A Bidder granting the request shall not be permitted to modify its Bid.
3.10	Bid Security	3.10.1	Unless otherwise specified in the BDS, the Bidder shall furnish as part of its Bid, a Bid Security for the amount specified in the BDS.
		3.10.2	Bid Security shall be 2% of the value of the Works indicated in the NIB. For bidders registered with the Procuring Entity, the bid security shall be 0.5% of the value of works indicated in the NIB. The bid security shall be in Indian Rupees, if not otherwise specified in the BDS.
		3.10.3	The Bid Security may be given in the form of a banker's Cheque or demand draft or bank guarantee of a Scheduled Bank in India, in specified format, or deposited through eGRAS/ net banking, if permitted.
		3.10.4	In lieu of Bid Security, a Bid Securing Declaration shall be taken from Government Departments and State Government Public Sector Enterprises, Autonomous bodies, Registered Societies, Cooperative Societies which are owned or controlled or managed by the State Government, Public Sector Enterprises of Central Government. For the Bid Securing Declaration the Bidder shall use the form included in Section IV [Bidding Forms].
		3.10.5	Scanned copy of Bid Security instrument or a Bid Securing Declaration shall necessarily accompany the sealed Bid. Any Bid not accompanied by Bid Security or Bid Securing Declaration, if not exempted, shall be liable to be rejected.
		3.10.6	Bid Security of a Bidder lying with the Procuring Entity in respect of other Bids awaiting decision shall not be adjusted towards Bid Security for the this Bid. The Bid Security originally deposited may, however be taken into consideration in case Bids are re-invited.
		3.10.7	The issuer of the Bid Security and the confirmer, if any, of the Bid Security, as well as the form and terms of the Bid Security, must be acceptable to the Procuring Entity.
		3.10.8	Prior to submitting its Bid, a Bidder may request the Procuring Entity to confirm the acceptability of a proposed issuer of a Bid Security or of a proposed confirmer, if different than as specified in ITB Clause 3.10.3. The Procuring Entity shall respond promptly to such a request.

		3.10.9	The bank guarantee presented as Bid Security shall be got confirmed from the concerned issuing bank. However, the confirmation of the acceptability of a proposed issuer or of any proposed confirmer does not preclude the Procuring Entity from rejecting the Bid Security on the ground that the issuer or the confirmer, as the case may be, has become insolvent or is under liquidation or has otherwise ceased to be creditworthy.
		3.10.10	The Bid Security of unsuccessful Bidders shall be refunded soon after final acceptance of successful Bid and signing of Contract Agreement and submitting Performance Security by successful Bidder pursuant to ITB Clause 6.4 [Performance Security].
		3.10.11	The Bid Security taken from a Bidder shall be forfeited in the following cases, namely:- i. when the Bidder withdraws or modifies his Bid after opening of Bids; or ii. when the Bidder does not execute the agreement in accordance with ITB Clause 6.3 [Signing of Contract] after issue of letter of acceptance/ placement of Work order within the specified time period; or iii. when the Bidder fails to commence the Works as per Work Order within the time specified; or iv. when the Bidder does not deposit the Performance Security in accordance with ITB Clause 6.4 [Performance Security]; in the prescribed time limit after the work order is placed; v. if the Bidder breaches any provision of the Code of Integrity prescribed for Bidders in the Act and Chapter VI of the Rules or as specified in ITB Clause 1.3 [Code of Integrity]; or vi. if the Bidder does not accept the correction of its Bid Price pursuant to ITB Sub-Clause 5.5 [Correction of Arithmetical Errors].
		3.10.12	In case of the successful bidder, the amount of Bid Security may be adjusted in arriving at the amount of the Performance Security, or refunded if the successful bidder furnishes the full amount of Performance Security. No interest will be paid by the Procuring Entity on the amount of Bid Security.

		3.10.13	The Procuring Entity shall promptly refund the Bid Security of the Bidders at the earliest of any of the following events, namely:- i. the expiry of validity of Bid Security; ii. the execution of agreement for procurement and Performance Security is furnished by the successful bidder; iii. the cancellation of the procurement process; or iv. the withdrawal of Bid prior to the deadline for presenting Bids, unless the Bidding Document stipulates that no such withdrawal is permitted.
		3.10.14	The Bid Security of a Joint Venture, Consortium or Association must be in the name of the Joint Venture, Consortium or Association that submits the Bid. If the Joint Venture, Consortium or Association has not been legally constituted at the time of Bidding, the members of the proposed consortium or JV shall enter in to an Agreement to form a legally constituted JV after the issue of Letter of Acceptance / Letter of Intent to them and also declare a partner as the lead partner in whose name the Bid Security may be submitted.
3.11	Format and Signing of Bid	3.11.1	All pages of the Technical and Financial Bid shall be digitally signed by the Bidder or authorized signatory on behalf of the Bidder. This authorization shall consist of a written confirmation as specified in the BDS and shall be attached to the Bid. In case of a Joint Venture, Consortium or Association, if the Joint Venture, Consortium or Association has not been legally constituted at the time of Bidding, all the members of the proposed Joint Venture, Consortium or Association shall digitally sign the Bid.
4. Submission and Opening of Bids			
4.1	Sealing and Marking of Bids	4.1.1	Bidders shall submit their Bids to the Procuring Entity electronically only on the e-procurement portal, eproc.raj.nic.in. In submission of their Bids, the Bidders should follow the step by step instructions given on the e-procurement portal.
		4.1.2	The Bidder shall enclose the Technical Bid and the Financial Bid in separate covers. The proof of payment of price of Bidding Document, processing fee and Bid Security shall be enclosed in third cover. The price of Bidding Document and Bid Security shall be paid in the name of the Procuring Entity and the processing fee shall be paid in the name of RISL.

4.2	Deadline for Submission of Bids	4.2.1	Bids shall be submitted electronically only up to the time and date specified in the Notice Inviting Bids and BDS or an extension issued thereof.
4.3	Withdrawal, Substitution and Modification of Bids	4.3.1	A Bidder may withdraw, substitute or modify its Bid after it has been submitted by submitting electronically on the e-procurement portal a written Withdrawal/ Substitutions/ Modifications etc. Notice on the e-procurement portal, duly digitally signed by the Bidder or his authorized representative, and shall include a copy of the authorization in accordance with ITB Sub-Clause 3.11.1 [Format and Signing of Bid]. The corresponding Withdrawal, Substitution or Modification of the Bid must accompany the respective written Notice. All Notices must be received by the Procuring Entity on the e-procurement portal prior to the deadline specified for submission of Bids in accordance with ITB Sub-Clause 4.2. [Deadline for Submission of Bids].
		4.3.2	No Bid shall be withdrawn, substituted or modified in the interval between the deadline for submission of the Bid and the expiration of the period of Bid validity specified in ITB Clause 3.9.[Period of Validity of Bids] or any extension thereof.
4.4	Bid Opening	4.4.1	The electronic Technical Bids shall be opened by the Bids opening committee constituted by the Procuring Entity at the time, date and place specified in the Bid Data Sheet in the presence of the Bidders or their authorized representatives, who choose to be present.
		4.4.2	The Bids opening committee may co-opt experienced persons in the committee to conduct the process of Bid opening.
		4.4.3	The Bidders may choose to witness the electronic Bid opening procedure online.
		4.4.4	The Financial Bids shall be kept unopened until the time of opening of the Financial Bids. The date, time, and location of electronic opening of the Financial Bids shall be intimated to the bidders who are found qualified by the Procuring Entity in evaluation of their Technical Bids.
		4.4.5	The Bids opening committee shall prepare a list of the Bidders or their representatives attending the opening of Bids and obtain their signatures on the same. The list shall also contain the representative's name and telephone number and corresponding Bidders' names and addresses. The authority letters brought by the

			representatives shall be attached to the list. The list shall be signed by all the members of Bids opening committee with date and time of opening of the Bids.
		4.4.6	First, covers marked as “WITHDRAWAL” shall be opened, read out, and recorded and the covers containing the corresponding Technical Bids and Financial Bids shall not be opened. No Bid shall be permitted to be withdrawn unless the corresponding withdrawal notice contains a valid authorization to request the withdrawal and is readout and recorded at Bid opening. If the withdrawal notice is not accompanied by the valid authorization, the withdrawal shall not be permitted and the corresponding Technical Bid shall be opened. Next, covers marked as “SUBSTITUTION Technical Bid” shall be opened, read out, recorded. The covers containing the Substitution Technical Bids and/ or Substitution Financial Bids shall be exchanged for the corresponding covers being substituted. Only the Substitution Technical Bids shall be opened, read out, and recorded. Substitution Financial Bids will remain unopened in accordance with ITB Sub-Clause 4.4.4. No Bid shall be substituted unless the corresponding substitution notice contains a valid authorisation to request the substitution and is read out and recorded at Bid opening. Covers marked as “MODIFICATION Technical Bid” shall be opened thereafter, read out and recorded with the corresponding Technical Bids. No Technical Bid and/ or Financial Bid shall be modified unless the corresponding modification notice contains a valid authorization to request the modification and is read out and recorded at opening of Technical Bids. Only the Technical Bids, both Original as well as Modification, are to be opened, read out, and recorded at the opening. Financial Bids, both Original as well as Modification, will remain unopened in accordance with ITB Sub-Clause 4.4.4.
		4.4.7	All other covers containing the Technical Bids shall be opened one at a time and the following read out and recorded- i. the name of the Bidder; ii. whether there is a modification or substitution; iii. whether proof of payment of Bid Security or Bid Securing Declaration, if required, payment of

			price of the Bidding Document and processing fee have been enclosed; iv. any other details as the Bids opening committee may consider appropriate. After all the Bids have been opened, their hard copies shall be printed and shall be initialed and dated on the first page and other important papers of each Bid by the members of the Bids opening committee.
		4.4.8	Only Technical Bids shall be read out and recorded at the bid opening and shall be considered for evaluation. No Bid shall be rejected at the time of opening of Technical Bids except Alternative Bids (if not permitted) and Bids not accompanied with the proof of payment of the required price of Bidding Document, processing fee and Bid Security.
		4.4.9	The Bids opening committee shall prepare a record of opening of Technical Bids that shall include, as a minimum: the name of the Bidder and whether there is a withdrawal, substitution, modification, or alternative offer (if they were permitted), any conditions put by Bidder and the presence or absence of the price of Bidding Document, processing fee and Bid Security. The Bidders or their representatives, who are present, shall sign the record. The members of the Bids opening committee shall also sign the record with date.
		4.4.10	After completion of the evaluation of the Technical Bids, the Procuring Entity shall invite Bidders who have submitted substantially responsive Technical Bids and who have been determined as being qualified to attend the electronic opening of the Financial Bids. The date, time, and location of the opening of Financial Bids will be intimated in writing by the Procuring Entity. Bidders shall be given reasonable notice of the opening of Financial Bids.
		4.4.11	The Procuring Entity shall notify Bidders in writing whose Technical Bids have been rejected on the grounds of being substantially non-responsive and not qualified in accordance with the requirements of the Bidding Document.
		4.4.12	The Bids opening committee shall conduct the electronic opening of Financial Bids of all Bidders who submitted substantially responsive Technical Bids and have qualified in evaluation of Technical Bids, in the presence of Bidders or their representatives who choose to be present at the address, date and time specified by the Procuring Entity.

		4.4.13	All covers containing the Financial Bids shall be opened one at a time and the following read out and recorded- i. the name of the Bidder; ii. whether there is a modification or substitution; iii. the Bid Prices; iv. any other details as the Bids opening committee may consider appropriate. After all the Bids have been opened, their hard copies shall be printed and shall be initialed and dated on the first page of the each Bid by the members of the Bids opening committee. All the pages of the Price Schedule and letters, Bill of Quantities attached shall be initialed and dated by the members of the committee. Key information such as prices, completion period, etc. shall be encircled and unfilled spaces in the Bids shall be marked and signed with date by the members of the Bids opening committee.
		4.4.14	The Bids opening committee shall prepare a record of opening of Financial Bids that shall include as a minimum: the name of the Bidder and whether there is a withdrawal, substitution, or modification, the Bid Price, any conditions, any discounts and alternative offers (if they were permitted). The Bidders or their representatives, who are present, shall sign the record. The members of the Bids opening committee shall also sign the record with date.
5. Evaluation and Comparison of Bids			
5.1	Confidentiality	5.1.1	Information relating to the examination, evaluation, comparison, and post-qualification of Bids, and recommendation of contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on Contract award is communicated to all Bidders.
		5.1.2	Any attempt by a Bidder to influence the Procuring Entity in its examination of qualification, evaluation, comparison of the Bids or Contract award decisions may resulting in the rejection of its Bid, in addition to the legal action which may be taken by the Procuring Entity under the Act and the Rules.
		5.1.3	Notwithstanding ITB Sub-Clause 5.1.2 [Confidentiality], from the time of opening the Bid to the time of Contract award, if any Bidder wishes to contact the Procuring Entity on any matter related to the Bidding process, it shall do so in writing.

		5.1.4	In addition to the restrictions specified in section 49 of the Act, the Procuring Entity, while procuring a subject matter of such nature which requires the procuring Entity to maintain confidentiality, may impose condition for protecting confidentiality of such information.
5.2	Clarification of Technical or Financial Bids	5.2.1	To assist in the examination, evaluation, comparison and qualification of the Technical or Financial Bids, the Bid evaluation committee may, at its discretion, ask any Bidder for a clarification regarding his Bid. The committee's request for clarification and the response of the Bidder shall be in writing.
		5.2.2	Any clarification submitted by a Bidder with regard to his Bid that is not in response to a request by the Bid evaluation committee shall not be considered.
		5.2.3	No change in the prices or substance of the Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetical errors discovered by the Bid evaluation committee in the evaluation of the financial Bids.
		5.2.4	No substantive change to qualification information or to a submission, including changes aimed at making an unqualified Bidder, qualified or an unresponsive submission, responsive shall be sought, offered or permitted.
5.3	Deviations, Reservations and Omissions in Technical or Financial Bids	5.3.1	During the evaluation of Technical or Financial Bids, the following definitions apply: i. "Deviation" is a departure from the requirements specified in the Bidding Document; ii. "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Document; and iii. "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Document.
5.4	Nonmaterial Non conformities in Technical or Financial Bids	5.4.1	Provided that a Technical or Financial Bid is substantially responsive, the Procuring Entity may waive any nonconformities (with recorded reasons) in the Bid that do not constitute a material deviation, reservation or omission.
		5.4.2	Provided that a Technical or Financial Bid is substantially responsive, the Procuring Entity may request the Bidder to submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities or omissions in the Bid related to documentation requirements. Request for information or documentation on such

			nonconformities shall not be related to any aspect of the Financial Proposal of the Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.
		5.4.3	Provided that a Technical or Financial Bid is substantially responsive, the Procuring Entity will rectify nonmaterial nonconformities or omissions (with recorded reasons). To this effect, the Bid Price shall be adjusted during evaluation of Financial Proposals for comparison purposes only, to reflect the price of the missing or non- conforming item or component. The adjustment shall be made using the method indicated in Section III, Evaluation and Qualification Criteria.
5.5	Correction of Arithmetical Errors in Financial Bid	5.5.1	Provided that a Financial Bid is substantially responsive, the Bid evaluation committee shall correct arithmetical errors during evaluation of Financial Bid on the following basis: i. if there is a discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, the unit price shall prevail and the total price shall be corrected, unless in the opinion of the Procuring Entity there is an obvious misplacement of the decimal point in the unit price, in which case the total price as quoted shall govern and the unit price shall be corrected; ii. if there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and iii. if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (i) and (ii) above.
		5.5.2	If the Bidder that submitted the lowest evaluated Bid does not accept the correction of errors, its Bid shall be disqualified and its Bid Security shall be forfeited or its Bid Securing Declaration shall be executed.
5.6	Preliminary Examination of Technical or Financial Bids	5.6.1	The Procuring Entity shall examine the Technical or Financial Bids to confirm that all documents and technical documentation requested in ITB Sub-Clause 3.3 [Documents Comprising the Bid] have been provided, and to determine the completeness of each document submitted.
		5.6.2	The Procuring Entity shall confirm, following the opening of the Technical or Financial Bids, that the

			following documents and information have been provided : i. Bid is signed, as per the requirements listed in the Bidding documents; ii. Bid has been sealed as per instructions provided in the Bidding documents; iii. Bid is valid for the period, specified in the Bidding documents; iv. Bid is accompanied by Bid Security or Bid securing declaration; v. Bid is unconditional and the Bidder has agreed to give the required performance Security; vi. Price Schedules in the Financial Bids are in accordance with ITB Clause 3.4 [Bid Submission Sheets and Price Schedules]; vii. written confirmation of authorization to commit the Bidder; viii. Declaration by the Bidder in compliance of Section 7 and 11 of the Act; and ix. other conditions, as specified in the Bidding Document are fulfilled.
5.7	Responsiveness of Technical or Financial Bids	5.7.1	The Procuring Entity's determination of the responsiveness of a Technical or Financial Bid is to be based on the contents of the Bid itself, as defined in ITB Sub-Clause 3.3 [Documents Comprising the Bid].
		5.7.2	A substantially responsive Technical or Financial Bid is one that meets without material deviation, reservation, or omission to all the terms, conditions, and specifications of the Bidding Document. A material deviation, reservation, or omission is one that: (a) if accepted, would- i. affect in any substantial way the scope, quality, or performance of the Goods and Related Services specified in Section V, Schedule of Supply; or ii. limits in any substantial way, inconsistent with the Bidding Document ,the Procuring Entity's rights or the Bidder's obligations under the proposed Contract; or (b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.
		5.7.3	The Procuring Entity shall examine the technical aspects of the Bid in particular, to confirm that requirements of Section V, Procuring Entity's

			Requirements have been met without any material deviation, reservation, or omission.
		5.7.4	If a Technical or Financial Bid is not substantially responsive to the Bidding Document, it shall be rejected by the Procuring Entity and may not subsequently be made responsive by the Bidder by correction of the material deviation, reservation, or omission.
5.8	Examination of Terms and Conditions of the Technical or Financial Bids	5.8.1	The Procuring Entity shall examine the Bids to confirm that all terms and conditions specified in the GCC and the SCC have been accepted by the Bidder without any material deviation or reservation.
		5.8.2	The Procuring Entity shall evaluate the technical aspects of the Bid submitted in accordance with ITB Clauses 3.3 [Documents Comprising the Bid] and to confirm that all requirements specified in Section V [Procuring Entity's Requirements] of the Bidding Document and all amendments or changes requested by the Procuring Entity in accordance with ITB Clause 2.3 [Amendment of Bidding Document] have been met without any material deviation or reservation.
5.9	Evaluation of Qualification of Bidders in Technical Bids	5.9.1	The determination of qualification of a Bidder in evaluation of Technical Bids shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB Clause 3.8 [Documents Establishing the Qualifications of the Bidder] and in accordance with the qualification criteria indicated in Section III [Evaluation and Qualification Criteria]. Factors not included in Section III, shall not be used in the evaluation of the Bidder's qualification.
5.10	Evaluation of Financial Bids	5.10.1	The Procuring Entity shall evaluate each Financial Bid, the corresponding Technical Bid of which has been determined to be substantially responsive
		5.10.2	To evaluate a Financial Bid, the Procuring Entity shall only use all the criteria and methodologies defined in this Clause and in Section III, Evaluation and Qualification Criteria. No other criteria or methodology shall be permitted.
		5.10.3	To evaluate a Financial Bid, the Procuring Entity shall consider the following: i. the Bid Price quoted in the Financial Bid; ii. price adjustment for correction of arithmetical errors in accordance with ITB Clause 5.5 [Correction of Arithmetical Errors];

			iii. adjustment of bid prices due to rectification of nonmaterial nonconformities or omissions in accordance with ITB Sub Clause 5.4.3 [Nonmaterial Nonconformities in Bids], if applicable.
		5.10.4	If the Bid, which results in the lowest evaluated Bid Price, is considered to be seriously unbalanced, or front loaded, in the opinion of the Procuring Entity, the Procuring Entity may require the Bidder to produce detailed rate analysis for any or all items of the Bill of Quantities, to demonstrate the internal consistency of those rates with the construction methods and schedule proposed. After evaluation of the rate analysis, taking into consideration, the schedule of estimated Contract payments, the Procuring Entity may require that the amount of the Performance security be increased at the cost of the Bidder to a level sufficient to protect the Procuring Entity against financial loss in the event of default of the successful Bidder under the Contract.
5.11	Comparison of Bids	5.11.1	The Procuring Entity shall compare all substantially responsive Financial Bids to determine the lowest-evaluated Financial Bid in accordance with ITB Sub-Clause 5.10 [Evaluation of Financial Bids].
5.12	Negotiations	5.12.1	To the extent possible, no negotiations shall be conducted after the pre-Bid stage. All clarifications needed to be sought shall be sought in the pre-Bid stage itself.
		5.12.2	Negotiations may, however, be undertaken only with the lowest Bidder under the following circumstances- i. when ring prices have been quoted by the Bidders for the subject matter of procurement; **or** ii. when the rates quoted vary considerably and considered much higher than the prevailing market rates.
		5.12.3	The Bid evaluation committee shall have full powers to undertake negotiations. Detailed reasons and results of negotiations shall be recorded in the proceedings.
		5.12.4	The lowest Bidder shall be informed about negotiations in writing either through messenger or by registered letter and e-mail (if available). A minimum time of seven days shall be given for calling negotiations. In case of urgency, the Bid evaluation committee, after recording reasons, may reduce the

			time, provided the lowest Bidder has received the intimation and consented to holding of negotiations.
		5.12.5	Negotiations shall not make the original offer made by the Bidder inoperative. The Bid evaluation committee shall have option to consider the original offer in case the Bidder decides to increase rates originally quoted or imposes any new terms or conditions.
		5.12.6	In case of non-satisfactory achievement of rates from lowest Bidder, the Bid evaluation committee may choose to make a written counter offer to the lowest Bidder and if this is not accepted by him, the committee may decide to reject and re-invite Bids or to make the same counter-offer first to the second lowest Bidder, then to the third lowest Bidder and so on in the order of their initial standing in the bid evaluation and work order be awarded to the Bidder who accepts the counter-offer.
		5.12.7	In case the rates even after the negotiations are considered very high, fresh Bids shall be invited.
5.13	Procuring Entity's Right to Accept Any Bid, and to Reject Any or All Bids	5.13.1	The Procuring Entity reserves the right to accept or reject any Bid, and to annul the Bidding process and reject all Bids at any time prior to Contract award without assigning any reasons thereof and without there by incurring any liability to the Bidders.
6. Award of Contract			
6.1	Procuring Entity's Right to Vary Quantities	6.1.1	If the Procuring Entity does not procure any subject matter of procurement or procures less than the quantity specified in the Bidding Document due to change in circumstances, the Bidder shall not be entitled for any claim or compensation except otherwise provided in the Bidding Document.
		6.1.2	Order for additional quantity of an item of the Works up to 50 percent of the original quantity of that item in the Bill of Quantities and for extra items not provided for in the Bill of Quantities may be given but the amount of the additional quantities and extra items, taken together, shall not exceed 50 percent of the Contract Price.
6.2	Acceptance of the successful Bid and award of contract	6.2.1	The Procuring Entity after considering the recommendations of the Bid Evaluation Committee and the conditions of Bid, if any, financial implications, samples, test reports, etc., shall accept or reject the successful Bid.

		6.2.2	Before award of the Contract, the Procuring Entity shall ensure that the price of successful Bid is reasonable and consistent with the required specifications.
		6.2.3	A Bid shall be treated as successful only after the competent authority has approved the procurement in terms of that Bid.
		6.2.4	The Procuring Entity shall award the contract to the Bidder whose offer has been determined to be the lowest in accordance with the evaluation criteria set out in the Bidding Document if the Bidder has been determined to be qualified to perform the contract satisfactorily on the basis of qualification criteria fixed for the Bidders in the Bidding Document for the subject matter of procurement.
		6.2.5	Prior to the expiration of the period of validity of Bid, the Procuring Entity shall inform the successful Bidder in writing, by registered post or email, that its Bid has been accepted.
		6.2.6	If the issuance of formal letter of acceptance (LOA) is likely to take time, in the meanwhile a Letter of Intent (LOI) may be sent to the Bidder. The acceptance of an offer is complete as soon as the letter of acceptance or letter of intent is posted and/ or sent by email (if available) to the address of the Bidder given in the Bidding Document.
6.3	Signing of Contract	6.3.1	In the written intimation of acceptance of its Bid sent to the successful Bidder, it shall also be requested to execute an agreement in the format given in the Bidding Document on a non-judicial stamp of requisite value at his cost and deposit the Performance Security or a Performance Security Declaration, if applicable, within a period specified in the BDS or where the period is not specified in the BDS, then within fifteen days from the date on which the LOA or LOI is dispatched to the Bidder. In case the successful bidder is a JV still to be legally constituted, all parties to the JV shall sign the Agreement.
		6.3.2	If the Bidder, whose Bid has been accepted, fails to sign a written procurement contract or fails to furnish the required Performance Security or Performance Security Declaration within the specified time period, the Procuring Entity shall forfeit the Bid Security of the successful bidder / execute the Bid Securing Declaration and take required action against it as per the provisions of the Act and the Rules.

		6.3.3	The Bid Security, if any, of the Bidder whose Bid could not be accepted shall be refunded soon after the contract with the successful Bidder is signed and his Performance Security is obtained. Until a formal contract is executed, LOA or LOI shall constitute a binding contract.
6.4	Performance Security	6.4.1	Performance Security shall be solicited from the successful Bidder except State Govt. Departments and undertakings, corporations, autonomous bodies, registered societies, co-operative societies which are owned or controlled or managed by the State Government and undertakings of Central Government. However, a Performance Security Declaration shall be taken from them. The State Government may relax the provision of Performance Security in particular procurement.
		6.4.2	(i) The amount of Performance Security shall be ten percent, or as specified in the BDS, of the amount of the Work Order. The currency of Performance Security shall be Indian Rupees, if otherwise not specified in BDS. (ii) If the Bid, which results in the lowest evaluated bid price, is seriously unbalanced or front loaded in the opinion of the Procuring Entity, the Procuring Entity 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, taking into consideration the schedule of estimated Contract payments, the Procuring Entity may require that the amount of the performance security be increased (to a maximum of 20% of the bid value of such items) at the expense of the Bidder to a level sufficient to protect the Procuring Entity against financial loss in the event of default of the successful Bidder under the Contract.
		6.4.3	Performance Security shall be furnished in one of the following forms as applicable- (a) Deposit through eGRAS; or (b) Bank Draft or Banker's Cheque of a Scheduled Bank in India; or (c) National Savings Certificates and any other script/ instrument under National Savings Schemes for promotion of small savings issued by a Post Office in Rajasthan, if the same can be pledged under the relevant rules. They shall be accepted at their

			surrender value at the time of Bid and formally transferred in the name of the Procuring Entity with the approval of Head Post Master; or (d) Bank guarantee. It shall be got verified from the issuing bank. Other conditions regarding bank guarantee shall be same as specified in ITB Sub-Clause 3.10 [Bid Security]; or (e) Fixed Deposit Receipt (FDR) of a Scheduled Bank. It shall be in the name of the Procuring Entity on account of Bidder and discharged by the Bidder in advance. The Procuring Entity shall ensure before accepting the Fixed Deposit Receipt that the Bidder furnishes an undertaking from the bank to make payment/ premature payment of the Fixed Deposit Receipt on demand to the Procuring Entity without requirement of consent of the Bidder concerned. In the event of forfeiture of the Performance Security, the Fixed Deposit shall be forfeited along with interest earned on such Fixed Deposit. (f) The successful Bidder at the time of signing of the Contract agreement, may submit option for deduction of Performance Security from his each running and final bill @ 10% of the amount of the bill.
		6.4.4	Performance Security furnished in the form of a document mentioned at options (a) to (e) of Sub-Clause 6.4.3 above, shall remain valid for a period of sixty days beyond the date of completion of all contractual obligations of the Bidder, including operation and / or maintenance and defect liability period, if any.
		6.4.5	Failure of the successful Bidder to submit the above-mentioned Performance Security or sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security. In that event the Procuring Entity may either cancel the procurement process or if deemed appropriate, award the Contract at the rates of the lowest Bidder, to the next lowest evaluated Bidder whose offer is substantially responsive and is determined by the Procuring Entity to be qualified to perform the Contract satisfactorily.
		6.4.6	Forfeiture of Performance Security: Amount of Performance Security in full or part may be forfeited in the following cases:- i. when the Bidder does not execute the agreement in accordance with ITB Clause 6.3 [Signing of

			Contract] within the specified time; after issue of letter of acceptance; or ii. when the Bidder fails to commence the Works as per Work order within the time specified; or iii. when the Bidder fails to complete Contracted Works satisfactorily within the time specified; or iv. when any terms and conditions of the contract is breached; or v. to adjust any established dues against the Bidder from any other contract with the Procuring Entity; or vi. if the Bidder breaches any provision of the Code of Integrity prescribed for the Bidders specified in the Act, Chapter VI of the Rules and this Bidding Document. vii. Notice of reasonable time will be given in case of forfeiture of Performance Security. The decision of the Procuring Entity in this regard shall be final.
7. Redressal of Grievances during Procurement Process (Appeals)			
7	Grievance handling procedure during procurement process	7.1	Any grievance of a Bidder pertaining to the procurement process shall be by way of filing an appeal to the First or Second Appellate Authority, as the case may be, as specified in the BDS, in accordance with the provisions of chapter III of the Act and chapter VII of the Rules and as given in Appendix A to these ITB.

Appendix A: Grievance Handling Procedure during Procurement Process (Appeals)

(1) Filing an appeal.- If any Bidder or prospective Bidder is aggrieved that any decision, action or omission of the Procuring Entity is in contravention to the provisions of the Act or the Rules or the Guidelines issued there under, he may file an appeal to First or Second Appellate Authority, as the case may be, as may be designated for the purpose, within a period of ten days or such other period as may be specified in the pre-qualification documents, Bidder registration documents or Bidding documents, as the case may be, from the date of such decision or action, omission, as the case may be, clearly giving the specific ground or grounds on which he feels aggrieved:

Provided that after the declaration of a Bidder as successful in terms of section 27 of the Act, the appeal may be filed only by a Bidder who has participated in procurement proceedings:

Provided further that in case a Procuring Entity evaluates the technical Bid before the opening of the financial Bid, an appeal related to the matter of financial Bid may be filed only by a Bidder whose technical Bid is found to be acceptable.

(2) Appeal not to lie in certain cases. - No appeal shall lie against any decision of the Procuring Entity relating to the following matters, namely:-

a) determination of need of procurement;
b) provisions limiting participation of Bidders in the Bid process;
c) the decision of whether or not to enter into negotiations;
d) cancellation of a procurement process;
e) applicability of the provisions of confidentiality.

(3) Form of Appeal.-

a) An appeal under sub-section (1) or (4) of section 38 shall be in the annexed Form along with as many copies as there are respondents in the appeal.
b) Every appeal shall be accompanied by an order appealed against, if any affidavit verifying the facts stated in the appeal and proof of payment of fee.
c) Every appeal may be presented to First Appellate Authority or Second Appellate Authority, as the case may be, in person or through registered post or authorized representative.

(4) Fee for filing appeal.-

a) Fee for first appeal shall be rupees two thousand five hundred and for second appeal shall be rupees ten thousand, which shall be non-refundable.
b) The fee shall be paid in the form of bank demand draft or banker's Cheque of a Scheduled Bank payable in the name of Appellate Authority concerned.

(5) Procedure for disposal of appeals.-

a) The First Appellate Authority or Second Appellate Authority, as the case may be, upon filing of appeal, shall issue notice accompanied by copy of appeal, affidavit and documents, if any, to the respondents and fix date of hearing.
b) On the date fixed for hearing, the First Appellate Authority or Second Appellate Authority, as the case may be, shall,-
   (i) hear all the parties to appeal present before him; and
   (ii) peruse or inspect documents, relevant records or copies thereof relating to the matter.
c) After hearing the parties, perusal or inspection of documents and relevant records or copies thereof relating to the matter, the Appellate Authority concerned shall

pass an order in writing and provide the copy of order to the parties to appeal free of cost.

d) The order passed under sub-clause (c) above shall be placed on the State Public Procurement Portal.

Annexure

FORM No. 1
[See rule 83]

Memorandum of Appeal under the Rajasthan Transparency in Public Procurement Act, 2012

Appeal No ……of ……
Before the …… (First / Second Appellate Authority)

1. Particulars of appellant:
(i)Name of the appellant:
(ii) Official address, if any:
(iii) Residential address:
2. Name and address of the respondent(s):
(1).
(2).
(3).
3. Number and date of the order appealed against and name and designation of the officer / authority who passed the order (enclose copy), or a statement of a decision, action or omission of the Procuring Entity in contravention to the provisions of the Act by which the appellant is aggrieved:
4. If the Appellant proposes to be represented by a representative, the name and postal address of the representative:
5. Number of affidavits and documents enclosed with the appeal:
6. Grounds of appeal:
..... …… …… (Supported by an affidavit)
7. Prayer:
……..……
……..……
……

Place …….
Date……

Section-II : Bid Data Sheet

SECTION II - BIDDING DATA SHEET (BDS)

The following specific data for the works shall complement, amend, or supplement the provisions in Section I: Instructions to Bidders (ITB). Whenever there is a conflict, the provisions herein shall prevail over those in the ITB.

Instructions to Bidders Clause Reference

A. Introduction

ITB. 1.1.1	The Number of the Invitation for Bids (NIT) is USCL/E-7/ 2017-18 The Procuring Entity is: **Udaipur Smart City Limited (USCL)** Representative of the Procuring Entity: **Chief Executive Officer, Udaipur Smart City Limited (USCL), Udaipur** Name of Town: **Udaipur** Name of the works: **Udaipur Integrated Infrastructure Package for ABD area, Udaipur** (Six Components, as mentioned below): 1. Design, Rehabilitation, Up-gradation and Construction of water distribution network and domestic 24X7 water supply in ABD area of Udaipur city; 2. Design, Rehabilitation, Up-gradation and Construction of sewerage network in ABD area; 3. Design, Undergrounding of power, telecom and other cables along with Rehabilitation, Up-gradation and Construction of power distribution network and domestic connections across core area of Udaipur city; 4. Design and Construction of Utility duct across core area of Udaipur city; and 5. Design and Relaying of Roads & Drain in ABD area of Udaipur City. 6. Design, Provision, Installation of Supervisory Control and Data Acquisition (SCADA) system (Detailed Scope of work has been defined in Section 5.)
	Add the following Clauses;
1.1.2	**Period of Completion**: The **Physical Works** of all the components, in all respects, shall be completed in its entirety within **Twenty Four (24) months** (including a **Design period of 6 months**) to be calculated from the date of signing of the Contract Agreement or such other Start Date as may be specified by the Employer. **Defect Liability period (DLP)** will be **one year** **Operation and Maintenance** of the assets thus created will also have to be carried out by the selected contractor for a period of **10 Years,** from the date of issue of Completion Certificate
1.1.3	**The type of Contract is:** Admeasurement (item rate basis)
ITB 1.4.1	Joint Ventures and / or Consortiums are permitted, comprising not more than **Four (4)** firms/ companies. The equity under JV of lead firm should be 51% at the minimum and that of other partners should be 15% at the minimum.
ITB 1.4.2	**"Bidders of any Nationality"** are permissible**.**
ITB 1.4.5	The Bidder / all partners of JV must be a person/ private company/ organization of any State Govt. / Central Govt. / PSU / Govt. Autonomous Body / Govt. Undertaking of any country.

ITB 1.4.8	The bidding process is open to bidders who fulfil the eligibility criteria prescribed in section III of this bid document.
ITB 1.4.9	Each bidder shall upload on-line / submit only one bid for one work. A bidder who submits or participates in more than one bid for the particular Work will be disqualified.

B. Bidding Documents

ITB 2.1.3	This is an "on-line tender". Therefore, tender documents in physical form shall not be available for sale but can be downloaded from the website and the bidder will pay **Rs100,000/-**, as document fee while submitting the filled-up Bidding document to the Procuring Entity along with the processing fee of **Rs 1000/-** (Rs. One thousand only)separately in favour of RISL, Jaipur The bidder should submit, by date & time specified in bid document, in original, hard copies of – (i) cost of bid document as **Rs. 100,000**/- (Rs. One lacs only) in the form of DD/Banker's Cheque of a scheduled bank in India or eGRAS in the name of **Chief Executive Officer, Udaipur Smart City Limited** payable at **Udaipur**, (ii) Bid processing fee of **Rs. 1,000/-** in the form of DD in the name of **Managing Director, RISL, Udaipur** payable at **Udaipur**, (iii) Bid Security as per RTPP Rules, 2013 (iv) Letter of Technical Bid, (v) Power of Attorney and (vi) Joint Venture Agreement. The bidder should upload scanned copies of these documents on e-procurement website along with their technical bids.
ITB 2.2.1	For Clarification purposes only, the Procuring Entity's address is: Chief Executive Officer, Udaipur Smart City Limited, Udaipur Email: mc_udaipur@rediffmail.com
ITB 2.2.2	A Pre-Bid conference will take place at the Meeting Hall of, Chief Executive Officer, Udaipur Smart city Limited on 10/08/2017 at 15:00 Hrs. Bidder is advised to visit the site at his own expenses and if any support is required, the SE/EE shall be contacted.
ITB 2.2.3	The Bidder is requested, to submit questions in writing, to reach the Procuring Entity preferably not later than one week before the Pre- Bid Conference. However, Department may also consider questions / queries raised in writing only, during the pre-bid conference.
ITB 2.3.1	Any addendum issued shall be part of the Bidding Document and shall be uploaded on the State Public Procurement Portal http://sppp.rajsthan.gov.in and the state e-procurement portal http://eproc.rajsthan.gov.in
ITB 2.3.2	To give prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Procuring Entity may, at its discretion, extend the deadline for the submission of the Bids, pursuant to ITB Sub-Clause 4.2 [Deadline for Submission of Bids], under due intimation to the Bidders by uploading it on the State Public Procurement Portal and its e-procurement portal.

C. Preparation of Bids

ITB 3.2.1	The language of the bid shall be: **English**
ITB 3.3.1	The on-line Bid shall comprise of two envelopes submitted simultaneously, one containing the Technical Bid and the other the Financial or Price Bid.
ITB 3.3.2	The Bidder shall submit the forms, declarations and documents, as specified in section IV of Bid Document, with the Technical Bid, in addition to the documents already mentioned in ITB 3.3.2
ITB 3.3.3	The Bidder shall upload the following documents with its Financial Bid: a) Financial Proposal Submission Sheet b) Preamble to BoQ c) And other details, as deemed necessary by the bidder.
ITB 3.5.1	Add following: i. The type of Contract is an Item Rate Contract only
ITB 3.5.2	The Prices quoted by the Bidder shall be fixed
ITB 3.5.3	All variations in taxes and duties shall be borne by the contractor.
ITB 3.9.1	The Bid validity period shall be **180 (One hundred and eight days)** days from deadline for submission of bids.
ITB 3.10.2	Bid security shall be Rs. **9,60,00,000**/- (Rupees Nine Crores Sixty Lacs only) for bidders Not Registered with the Procuring Entity.
ITB 3.10.3	A Bid Security shall be provided as a part of the bid in the form of a banker's Cheque or Demand Draft or Bank Guarantee of a Scheduled Bank in India, in specified format which shall remain valid for a period of 30 (thirty) days beyond the validity of the bid.
ITB 3.11.1	The written confirmation of authorization to sign on behalf of the Bidder shall consist of: Power of Attorney and only Digital signed copy shall be submitted through e-procurement website.

D. Submission and Opening of Bids

ITB 4.1.1	For bid submission purposes only, the Procuring Entity's address is: **Chief Executive Officer,** **Udaipur Smart City Limited** EMAIL: mc_udaipur@rediffmail.com **Bidders shall submit their Bids electronically only**. The Bidders shall submit the Bid online with all pages numbered serially and by giving an index of submissions. Each page of the submission shall be initialled by the Authorised Representative of the Bidder as per the terms of the tender. The Bidder shall be responsible for documents accuracy and correctness as per the version uploaded by the Procuring Entity and shall ensure that there are no changes caused in the content of the downloaded document. The bidder shall submit the same document offline till the prescribed time in NIT. The bidder shall follow the following instructions for online submission: i Bidder who wants to participate in bidding will have to procure digital certificate as per IT Act to sign their electronic bids. Offers which are not digitally signed will not be accepted. Bidder shall submit their offer in

	electronic format on above mentioned website after digitally signing the same. ii Cost of bid document is **Rs.100,000/-** per tender should be deposited by Non Refundable Demand Draft drawn in favor of Chief Executive Officer, Udaipur Smart City Limited, Udaipur payable at Udaipur, whereas the **Processing fee Rs. 1,000/-** should be deposited by Non Refundable Demand Draft drawn in favour of MD, RISL, Jaipur payable at Jaipur. Original documents along with above mentioned fees and other documents as per bid conditions, has to be deposited up to date and time provided in this bid. iii The Procuring Entity will not be responsible for any mistake occurred at the time of uploading of bid or thereafter. iv If holiday is declared on submission & opening date of tender the scheduled activity will take place on next working day. Bids are required to be submitted in Electronic Format, it shall be submitted on the e-procurement portal : http://eproc.rajathan.gov.in
ITB 4.2.1	The Deadline for electronic Bid submission is Date: **11/09/2017** Time: 15:00 Hrs
ITB 4.4.7 4.5.5	The on-line Bid opening shall take place at: The office of **Chief Executive Officer,** **Udaipur Smart city Limited**. EMAIL: mc_udaipur@rediffmail.com The tendering process shall be conducted on-line only; DD/BC tender fee, processing fee and Bid Security shall be submitted physically up to deadline described in tender document.
ITB 4.5.14, 4.5.15	The Procuring Entity will open the Financial proposal as per e-tendering procedure.

E. Award of Contract

ITB 5.11.1	The Bidder quoting the least cost to USCL would be selected for the assignment.
ITB 6.3.1	The period within which the Performance Security is to be submitted by the successful Bidder and the Contract Agreement is to be signed by him from the date of issue of Letter of Acceptance is 30 Days.
ITB 6.3.3	The procuring entity shall promptly return the bid security after the earliest of the following events, namely: 1. The expiry of validity of bid security 2. The execution of agreement for procurement and performance security is furnished by the successful bidder; 3. The cancellation of the procurement process; or 4. The withdrawal of bid prior to the deadline for presenting bids, unless the bidding documents stipulate that no such withdrawal is permitted.
ITB 6.4.2, 6.4.3, 6.4.4 Replace with following	Performance Security amounting to total **10% of contract value** shall be submitted as follows: (i) Contractor shall submit Performance Security @ 10% in advance at the time of signing of agreement in form of BG as per latest rules under RTPP act. The BG should be issued by any nationalized / scheduled bank and shall remain valid up to 60 days beyond defect liability period. Bank Guarantee

	submitted against the performance guarantee, shall be unconditional and encashable /invokable at Udaipur. (ii) If there is no reason to retain the PG, it shall be returned back to the contractor within 60 days after the satisfactory completion of the defect liability period. (iii) Refer clause 4.3.1 of Special condition of contract
7.1	A. First Appellate Authority shall be: Vice President USCL i.e. Collector Udaipur B. Second Appellate Authority shall be: Chairman USCL i.e. Principal Secretary, LSG, Government of Rajasthan

Section-III :
Evaluation and Qualification Criteria

SECTION III:
EVALUATION AND QUALIFICATION CRITERIA

A. Evaluation Criteria

The successful Bid will be the lowest evaluated responsive Bid, which qualifies technical evaluation. This evaluation will consist of the following:

1.1 Evaluation of the Bidder's Technical Proposal and Presentation will include an assessment of the Bidder's technical capacity to mobilize key equipment and personnel for the contract consistent with its proposal regarding work methods, scheduling, and material sourcing in sufficient detail.
1.2 Quantifiable Nonconformities, Errors and Omissions.
1.3 Demonstrate capability to undertake similar Works contracts, by documented demonstration of execution of similar type of works. The bidder will submit Completion Certificate from the Employer/s.

Price Enhancement Factor –

Note: The Price enhancement factor, as tabulated below, would apply to assess the cost of completed contractual experiences claimed in Clause 2.4.1; as per the year of completion.

Period of completion of contracts calculated from the date of bid submission	Multiplying Factor
Up and including One year	1.0
More than One year up to and including Two years	1.05
More than Two years up to and including Three years	1.10
More than Three years up to and including Four years	1.16
More than Four years up to and including Five years	1.22
More than Five years up to and including Six years	1.28
More than Six years up to and including Seven years	1.35
More than Seven years up to and including Eight years	1.42
More than Eight years up to and including Nine years	1.49
More than Nine years up to and including Ten years	1.57

B. Qualification Criteria:-

1. Eligibility:

	Requirement	Compliance Requirements			
		Single Entity	Joint Venture		
			All Partners Combined	Each Partner	One partner
i) Nationality	National / International firm	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement
ii) Conflict of Interest	No conflicts of interest in accordance with ITB Sub-clause 1.4.3	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement
iii) Debarment / charges of Transgression by any Procuring Entity.	Must declare	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement

2. Pending Litigation:

	Requirement	Compliance Requirements			
		Single Entity	Joint Venture		
			All Partners Combined	Each Partner	One partner
Pending Litigation	All pending litigation shall be treated as resolved against the Bidder and so shall in total not represent more than **50%** percent of the Bidder's net worth.	Must meet requirement by itself	N/A	Must meet requirement by itself	N/A

NOTE: CA certificate must clearly mention, with calculation that pending litigation in total is not more than 50% of Bidder's net worth. Net Worth must also be certified by CA and is to be submitted with the technical bid.

3. Technical Experience:

The bidder should have experience of the following in last ten financial years**;** experience in current year shall also be counted up to deadline for submission of bid:

Criteria	**Compliance Requirements**			
	Single Entity	**Joint Venture (permitted)**		
Requirement		**All Partners Combined**	**Each Partner**	**One partner**
Should have substantially completed (as per definition given below) at least one contract for each component with 60% of estimated project component cost that has been successfully or substantially completed within the last **10 (Ten)** years and that is similar to the proposed works; **Udaipur Integrated Infrastructure Project:** having minimum experience, as detailed below:- 1. Design, Rehabilitation, Up-gradation and Construction of water distribution network and domestic 24X7water supply in ABD area of Udaipur city (INR 65 Cr); 2. Design, Rehabilitation, Up-gradation and Construction of sewerage network in ABD area (INR 169 Cr); 3. Design, Undergrounding of power, telecom and other cables along with Rehabilitation, Up-gradation and Construction of power distribution network and domestic connections across core area of Udaipur city (INR 108 Cr); 4. Design and Construction of Utility duct across core area	Must meet requirement	Must meet requirement	NA	NA

of Udaipur city (INR 51 Cr); and 5. Design and Relaying of Roads & Drain in ABD area of Udaipur City (INR 79 Cr); 6. Design, Provision, Installation of Supervisory Control and Data Acquisition (SCADA) system (INR 5 Cr); <u>Substantially completed means</u>: i. Contractor has completed the works but could not commission the same because of hindrances beyond control of contractor. OR ii Contractor has completed and commissioned the work at least of the amount required for qualification, out of large size contract. In case of JV, all partners combined should meet the requirement				

4. Clients certificate of experience must clearly indicate whether

(i) Completed and commissioned

Or

(ii) Substantially completed as per definition given above

Note:

i) The Bidder shall submit copies of Work Orders, Completion Certificates in support of their experience claims. Only works of Govt. / PSU / Autonomous bodies under Govt. Sector shall be considered;

ii) The works which have been completed during the period mentioned above, though may have commenced earlier will be considered as experience.

iii) For considering experience of the bidder, out of its experience as JV, its share of works within the JV shall be considered with relevant documentation/ certificates.

iv) JV and / or Consortium shall comprise of not more than four firms/companies. The minimum equity of the lead firm of the JV must be 51% and that of the other firms must be 15%, at the minimum.

5. Financial:

Criteria	Compliance Requirements			
	Single Entity	Joint Venture (permitted)		
Requirement		All Partners Combined	Each Partner	One partner
5.1 Networth				
Net worth shall be positive in last financial year i.e. **2016-17**	Must meet requirement	Must meet requirement	Must meet requirement	NA
5.2 Turnover				
Average Annual Turnover of **last three Financial years (2014-15 to 2016-17)** should be equal to or more than **Rs. 480.00 Crore**.	Must meet requirement	Must meet requirement	Must meet minimum 15% requirement	Lead member must meet minimum 51% requirement
5.3 Working Capital				
Working Capital based on the current assets and current liabilities (including the short term loan repayments due in current years) should be more than or equal to **Rs120.00 Crore** (Available working capital should be evaluated as current assets + revolving line of credit – current liabilities including loan repayments due within one year). NOTE: certificate of CA must be submitted indicating clearly that the **working capital** is as per formula given in tender document and clearly stating the individual components. CA must also clearly mention that he has gone through the **revolving line of credit** which is issued by scheduled bank and bank's commitment is project specific, assured and without any ambiguity and shall be available till final completion of the project, otherwise bid shall not considered. For revolving line of credit, Banks letter should be attached. The bank issuing revolving line of credit has to be scheduled bank as per format, otherwise it will not be considered.	Must meet requirement	Must meet requirement	Must meet minimum 15% requirement	Lead member must meet minimum 51% requirement

5.4 BID CAPACITY:				
Bid Capacity: The bid capacity of the bidder shall not be less than **Rs. 480 Crore**. The formula for calculating Bid capacity is given here Bid Capacity=(2xAxN)-B Where **A**= Maximum value of Annual Turnover from in any one year during the last three financial years (14-15,15-16, 16-17) (updated to present price level) **N**=Prescribed completion period of the work for which bids are invited in years, **B**= Value at present price level (2016-17) of existing commitments and ongoing works to be completed during N period i.e., the period of completion of works for which bids are invited.	Must meet requirement	Must meet requirement	Must meet minimum 15% requirement	Lead member must meet minimum 51 % requirement

NOTE:

The **certificate of CA** regarding **Net worth, Turnover, Working Capital, revolving line of credit and Bid Capacity must be submitted otherwise bid shall not be considered**. The certificate should clearly show the calculation how the Bid Capacity is calculated as per formula given in tender. The contractor should submit an undertaking on a Non Judicial stamp paper of value Rs. 500.00 that he has divulged all necessary and relevant information regarding current contract commitments for projects being executed by the bidder, which is necessary for calculation of B value for the calculation of Bid Capacity. The audited balance sheet of last five years shall be provided.

Section-IV : Bidding Forms

SECTION IV: BIDDING FORMS

Table of contents

4.1 TECHNICAL PROPOSAL [WITH REFERENCE TO SECTION III]

CHECK LIST

In addition to the forms given in this section, a Technical Proposal must necessarily contain the following, otherwise the bid shall be considered incomplete and may lead to non-responsive.:

1. Notice Inviting Bid
2. CA's certificates for Networth, Turnover, Working Capital, Revolving Line of Credit and Bid Capacity
3. Bank's letter as required in Tender Document (if applicable).
4. Sales Tax Registration in State of Rajasthan (Optional),
5. VAT / Sales Tax Clearance Certificate
6. GST Registration
7. Copy of PAN & TAN Numbers
8. Service Tax Registration, if required as per law
9. Proof of payment of Bid Security
10. Proof of Cost of bidding document or receipt of such cost.
11. Proof of Bid processing fee as specified.
12. Bid capacity stipulations as required in Tender Document.
13. Completion Certificates of works which have been cited in support of fulfillment of eligibility criteria as specified in Tender Document.
14. Work orders of works which have been cited in support of fulfillment of eligibility criteria as specified in Tender Document.
15. Drawings / designs / technical documents (if required) in support of works to be executed
16. Any modifications or withdrawal
17. Other documents considered necessary to strengthen the bid
18. JV agreement against which experience for eligibility is claimed to demonstrate clearly the JV members work in that JV
19. Check Points and Self appraisal sheet
20. Audited Annual Reports for last 3 years
21. Technical data sheet of quoted items.

4.2 Letter of Technical Bid

Technical Bid Submission Sheet

Date: _____ NIB No.: _____

To: _____

We, the undersigned declare that:

(a) We have examined and have no reservations to the Bidding Document, including Addenda No._____

(b) We offer to execute in conformity with the Bidding Document the following Works:

_____

(c) Our Bid shall be valid for a period of 180 days from the date fixed for the bid submission deadline in accordance with the Bidding Document, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(d) If our Bid is accepted, we commit to obtain a Performance Security in the amount of _____ percent of the Contract Price or Performance Security Declaration, as the case may be, for the due performance of the Contract;

(e) Our firm or suppliers for any part of the Contract, have nationalities from the eligible countries;

(f) We are not participating, as Bidder, in more than one Bid in this bidding process, other than alternative offers, if permitted, in the Bidding Document;

(g) Our firm, its affiliates or subsidiaries or suppliers has not been debarred by the State Government or the Procuring Entity;

(h) We understand that this Bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding contract between us, until a formal Contract is prepared and executed;

(i) We understand that you are not bound to accept the lowest evaluated bid or any other bid that you may receive;

(j) We agree to permit Government of Rajasthan or the Procuring Entity or their representatives to inspect our accounts and records and other documents relating to the bid submission and to have them audited by auditors appointed by the Procuring Entity;

(k) We have paid, or will pay the following commissions, gratuities, or fees, if any, with respect to the bidding process for execution of the Contract:

Name of Recipient	Address	Reason	Amount

(l) We declare that we have complied with and shall continue to comply with the provisions of the Code of Integrity including Conflict of Interest as specified for Bidders in the Rajasthan Transparency in Public Procurement Act, 2012, the Rajasthan Transparency in Public Procurement Rules, 2013 and this Bidding Document during this procurement process and execution of the Works as per the Contract;

(m) Other comments, if any:

Name/ address: _____

In the capacity of: _____

Signed: _____

Duly authorized to sign the Bid for and on behalf of:___ _____

Date: _____

Tel: _____ Fax: _____

E-mail: _____

4.3.1 Bid Security (Bank Guarantee Unconditional)*

Form of Bid Security

[insert Bank's Name, and Address of Issuing Branch or Office]
Beneficiary:*[Chief Executive Officer, Udaipur Smart City Limited]*

Date: ***[insert date]***

BID GUARANTEE No.:*[insert number]*

We have been informed that ***[insert name of the Bidder]*** (here in after called" the Bidder")has submitted to you its bid dated***[insert date]***(hereinafter called "the Bid")for the execution of ***[inert name of contract]***under Notice Inviting Bids No***. [Insert NIB number]*** ("theNIB").

Furthermore, we understand that, according to your conditions, bids must be supported by a bid guarantee.

At the request of the Bidder, we ***[insert name of Bank]*** hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of ----------***[insert amount in figures][insert amount in words] at the bank branch*** ____ ***located at Udaipur*** upon receipt by us of your first demand in writing accompanied by a written statement stating that the Bidder is in breach of its obligation(s) under the bid conditions, because the Bidder:

(a) has withdrawn its Bid during the period of bid validity specified by the Bidder in the Letter of Technical Bid; or
(b) having been notified of the acceptance of its Bid by the *Procuring Entity* during the period of bid validity,
    (i) fails or refuses to execute the Contract Agreement,
    (ii) fails or refuses to furnish the performance security, in accordance with the Instructions to Bidders(hereinafter "the ITB"),
(c) has not accepted the correction of mathematical errors in accordance with the ITB, or
(d) has breached a provision of the Code of Integrity specified in the TB;

This guarantee will expire: (a) if the Bidder is the successful Bidder, upon our receipt of copies of the contract signed by the Bidder and the performance security issued to you upon the instruction of the Bidder; and(b)if the Bidder is not the successful Bidder, upon the earlier of(i)our receipt of a copy of your notification to the Bidder of the name of the successful Bidder; or (ii)thirty days after the expiration of the validity of the Bidder's bid.

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

Signed: _____

[Insert signature of person whose name and capacity are shown]

NOTE: * - Scheduled Bank Only

Name: _____

[insert complete name of person signing the Bid Security]

In the capacity of: _____

[insert legal capacity of person signing the Bid Security]

Duly authorized to sign the Bid Security for and on behalf of_____

[insert name of the Bank]

Dated on day of ,

[insert date of signing]

Bank's Seal _____

*[**affix seal of the Bank]***

[Note: In case of a Joint Venture, the Bid-Security must be in the name of all partners to the Joint Venture/Lead bidder that submits the bid.]

4.3.2 Bid Security Declaration

Date: ***[insert date (as day, month and year)]***
Bid No.: ***[insert number of bidding process]***
Alternative No, if permitted: ***[insert identification No if this is a Bid for an alternative]***

To: ***[Chief Executive Officer, USCL, RAJASTHAN]***
We, the undersigned, declare that:
We understand that, according to your conditions, bids must be supported by a Bid-Securing Declaration.
We accept that we will automatically be suspended from being eligible for bidding in any contract with you, the Procuring Entity for the period of time of ***[insert number of months or years, as required by the Procuring Entity]*** starting on ***[insert date],*** if we are in breach of our obligation(s) under the bid conditions, because we:
(a) withdraw our Bid during the period of bid validity specified in the Letter of Bid; or
(b) do not accept the correction of errors in accordance with the Instructions to Bidders (hereinafter "the ITB"); or
(c) having been notified of the acceptance of our Bid by you, the Procuring Entity, during the period of bid validity, (i) fail or refuse to sign the Contract, if required, or (ii) fail or refuse to furnish the Performance Security Declaration, in accordance with the ITB; or
(d) breach any provisions of the Code of Integrity as specified in the ITB;
We understand this Bid-Securing Declaration shall expire if we are not the successful Bidder, upon the earlier of (i) our receipt of your notification to us of the name of the successful Bidder.

Signed: _____
[insert signature of person whose name and capacity are shown]
Name: _____
[insert complete name of person signing the Bid-Securing Declaration]
In the capacity of: _____
[insert legal capacity of person signing the Bid-Securing Declaration]
Duly authorized to sign the bid for and on behalf of: _____
[insert complete name of Bidder]
Dated on day of ,
[insert date of signing]
Corporate Seal _____
*[**affix corporate seal of the bidder]***
[Note: In case of a Joint Venture, the Bid-Securing Declaration must be in the name of all partners to the Joint Venture/ Lead bidder that submits the bid.]

4.4.1 Bidder's Qualification

To establish its qualifications to perform the contract in accordance with Section III (Evaluation and Qualification Criteria) the Bidder shall provide the information requested in the corresponding Information Sheets included hereunder.

4.4.1(a) Form ELI - 1: Bidder's Information Sheet

BIDDER'S INFORMATION	
Bidder's legal name	
In case of JV/Consortium, legal name of each partner	
Bidder's /all JV/Consortium partners country of constitution.	
Bidder's /all JV/Consortium partners year of constitution	
Bidder's /all JV/Consortium partners legal address in country of constitution	
Bidder's /all JV/Consortium partners authorized representative (name, address, telephone numbers, fax numbers, e-mail address)	
Attached are self attested copies of the following original documents: 1. In case of single entity, certificate of registration/ incorporation and memorandum of association or constitution of the legal entity named above. 2. Authorization to represent the firm or JV named in above. 3. In case of JV, letter of intent to form JV or JV agreement. 4. In case of Consortium, letter of intent to form consortium or JV consortium	

4.4.2 Form ELI : JV Information Sheet

Attach the Letter of Intent to form JV or certificate of registration/ incorporation and memorandum of association or constitution of the legal entity, if JV is already in existence.

Each member of a JV / must fill in this form

JV /consortium/ SPECIALIST CONTRACTOR'S INFORMATION	
Bidder's legal name	
JV /consortium Partner's legal name	
JV /consortium Partner's financial share in the JV	
JV /consortium Partner's country of constitution	
JV /consortium Partner's year of constitution	
JV /consortium Partner's legal address in country of constitution	
JV /consortium Partner's authorized representative information(name, address, telephone numbers, fax numbers, e-mail address)	
Attached are attested copies of the following original documents: 1. Certificate of registration/ incorporation and memorandum of association or constitution of the legal entity named above. 2. Authorization to represent the firm named above.	

4.4.3 Form LIT 1- Pending Litigation

Each Bidder or member of a JV / must fill in this form

Pending Litigation			
• No pending litigation in accordance with Section III (Evaluation and Qualification Criteria). • Pending litigation in accordance with Section III (Evaluation and Qualification Criteria)			
Year	Matter in Dispute	Value of Pending Claim in INR	Value of Pending Claim as a Percentage of Net Worth

4.4.4 Form EXP :Project Experience in Key Activities

Fill up one (1) form per contract

Contract with Similar Key Activities			
Contract No. . . . . .**of**.	**Contract Identification**		
Award Date		**Completion Date**	
Total Contract Amount	**----------Equivalent INR -----**		
If partner in a JV, specify participation of total contract amount	**Percent of Total**	**Amount**	
Employer's Name **Address** **Telephone Number** **Fax Number** **E-mail**			
Description of the key activities in accordance with Criteria.			
Udaipur Integrated Infrastructure Project 1) Design, Rehabilitation, Up-gradation and Construction of water distribution network and domestic 24X7water supply 2) Design, Rehabilitation, Up-gradation and Construction of sewerage; 3) Design, Undergrounding of power, telecom and other cables along with Rehabilitation, Up-gradation and Construction of power distribution network and domestic connections; 4) Design and Construction of Utility duct; and 5) Design and Relaying of Roads & Drain 6) Design, Provision, Installation of Supervisory Control and Data Acquisition (SCADA) system;			
Reference page number, copy of work order and completion certificate in support of above experience to be submitted.			

4.4.5 Format for assured Revolving line of credit facility

(*To be submitted by a Scheduled Bank on the Bank's Letter head*)

Date: (*Insert Date*)

To: ***Chief Executive Officer,***

Udaipur Smart City Limited,

Udaipur

Subject: Letter of Assurance for Revolving line of credit facility for INR ----

Dear Sir,

WHEREAS _____ [*name and address of Bidder*] (**hereinafter called the "Bidder"**) intends to submit a bid for---------- ---(name of contract package) ----------" under the Udaipur Smart City Limited (**hereinafter called the "Employer"**) in response to the Invitation for Bids issued by the Udaipur Smart City Limited through NIB no. ----------; and

WHEREAS the Bidder has requested that an assured revolving line of credit be provided to it for executing the ---------- ---(name of contract package) ----------**In the event that the Contract is awarded to it; then**

KNOW ALL THESE PEOPLE by these presents that We _____ [*name of Bank*] of _____ [*name of Country*] having our registered office at _____ [*address of registered office*] are willing to provide to _____ (the Bidder) a sum of up to _____ [*amount of guarantee in figures and words*] as an assured revolving line of credit for executing the Works under ---------- ---(name of contract package) ----------should the Bidder be awarded the contract based on its tendered prices.

We understand that this assurance may be taken into consideration by the Employer during evaluation of the Bidder's financial capabilities, and further assure that we intend to maintain this revolving line of credit until such time as the Works are completed and taken over by the Employer.

SEALED with the Common Seal of the said Bank on the ____ day of _____, 2017.
Date: _____
Signature of the Bank: _____
Witness: _____ Seal:_____
[Signature, name and address]

4.4.6 Declaration by the Bidder in compliance of Section 7 & 11 of the Act

Declaration by the Bidder/ JV

In relation to our Bid submitted to ……. *[enter designation and address of the procuring entity]* for procurement of …… *[insert name of the Works]* in response to their Notice Inviting Bids No…… Dated …….. we hereby declare under Section 7 and 11 of the Rajasthan Transparency in Public Procurement Act, 2012, that;

1. We possess the necessary professional, technical, financial and managerial resources and competence required by the Bidding Document issued by the Procuring Entity;

2. We have fulfilled our obligation to pay such of the taxes payable to the Central Government or the State Government or any local authority, as specified in the Bidding Document;

3. We are not insolvent, in receivership, bankrupt or being wound up, not have my/our affairs administered by a court or a judicial officer, not have my/our business activities suspended and are not the subject of legal proceedings for any of the foregoing reasons;

4. We do not have, and our directors and officers not have, been convicted of any criminal offence related to our professional conduct or the making of false statements or misrepresentations as to our qualifications to enter into a procurement contract within a period of three years preceding the commencement of this procurement process, or not have been otherwise disqualified pursuant to debarment proceedings;

5. We do not have a conflict of interest as specified in the Rajasthan Transparency in Public Procurement Act, the Rajasthan Transparency in Public Procurement Rules and this Bidding Document, which materially affects fair competition;

6. We have complied and shall continue to comply with the Code of Integrity as specified in the Rajasthan Transparency in Public Procurement Act, the Rajasthan Transparency in Public Procurement Rules and this Bidding Document, till completion of all our obligations under the Contract.

Date: Signature of Bidder

Place: Name:

Designation:

Address:

4.5 Letter of Financial Bid

Date: _____ NIT No.: _____

To,
Chief Executive Officer,
Udaipur Smart City Limited,
Udaipur

Sub: - Final Udaipur Integrated Infrastructure Project - Our Offer

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bidding Document, including Addenda No.:_____

(b) We offer to execute in conformity with the Bidding Document the following Works:

_____

(c) The total Price for our Bid, excluding any discounts offered, if permitted, in item (d) below is: _____

(d) The discounts offered, if permitted, and the methodologies for their application are:

_____

(e) We understand that this Bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding contract between us, until a formal Contract is prepared and executed.

(f) We understand that you are not bound to accept the lowest evaluated bid or any other bid that you may receive.

(g) Other comments, if any:

Name/ address: _____

In the capacity of: _____

Signed: _____

Duly authorized to sign the Bid for and on behalf of:___ _____

Date: _____

Tel: _____ Fax: _____

E-mail: _____

4.6 Power of Attorney

Power of Attorney for Authorized Representative

The firm M/s……..authorize the following Representative to sign and submit the tender document, negotiate terms and conditions for the contract, to sign the contract, to deal with the _____, to issue and receive correspondence related to all matters of the tender "--------". We / M/s _____ undertake the responsibility due to any act of the representative appointed hear by.

For Partnership Firm's

S. No.	Name of the All Partner	Signature of Partner with Seal
1.		
2.		
3		
4	Name and Designation of the person Authorized	
5	Attested Signature of the Authorized Representative	

For Limited Firm's

Name and Designation of the person Authorized	
Firm	
Address	
Telephone No.	
Fax No.	
Telex No.	
Authority By which the Powers is delegated	
Attested Signature of the Authorized Representative	
Name and Designation of person attesting the signatures	

4.7 Joint Venture Agreement (Between not more than four firms)

(ON Rs 1000 STAMP PAPER OR NOTARY)

Memorandum of Understanding for
JOINT VENTURE

This Memorandum of Understanding (hereinafter referred to as "MOU") is made and entered into this ---------- ("Effective Date").

BETWEEN

M/s. _____**,** a company incorporated, and having its registered office at _____.(Hereinafter referred to as the **"First Party"/ "One Partner");**

M/s. _____a company incorporated, and having Registered office at _____.(Hereinafter referred to as the **"Second Party"/ "Each Partner")**;

M/s. _____a company incorporated, and having Registered office at _____.(Hereinafter referred to as the **"Third Party"/ "Each Partner")**;

M/s. _____a company incorporated, and having Registered office at _____.(Hereinafter referred to as the **"Fourth Party"/ "Each Partner")**;

Hereinafter jointly referred to as the **"Parties"** and individually as **"Each Party"** or **"a Party"** as the case may be.

WHEREAS,

A) **The Udaipur Smart City Limited, Udaipur, Rajasthan (hereinafter referred to as the USCL or procuring entity) invited bid for**

_____,

(B) The **Parties** hereto formed a Joint Venture or will form a joint venture (hereinafter referred to as the **"JV")** to jointly execute the above project in all respect

(Note: In case of JV executed on notary basis and become the lowest successful bidder, Joint venture has to be registered within 15 days of issuing of LOA)

NOW THEREFORE IT IS HEREBY AGREED as follows

ARTICLE 1: JOINT VENTURE:

1.1. The Parties hereto agree to form the Joint Venture with _____ designated as the **One Partner and First Partner**.

1.2. _____ **shall be the Second Member – or Second Partner**

1.3. _____ **shall be the Third Member – or Third Partner**

1.4. _____ **shall be the Fourth Member – or Fourth Partner**

ARTICLE 2: JOINT VENTURE NAME:

2. The JV shall do business in the name of **"_____ Joint Venture".**

ARTICLE 3: JOINT AND SEVERAL LIABILITY:

3. The **Parties** hereto shall, for the above-referred **Projects**, be jointly and severally liable to the **Employer** for the execution of the Projects in accordance with the **Contract** till the actual completion of Contract including defect liability period and operation & maintenance as per bid conditions.

ARTICLE 4: PROPORTIONATE SHARE:

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

Lead Partner: Financial responsibility: **----------**
Physical responsibility: **----------**
Other Partners: Financial responsibility: **----------**
Physical responsibility: **----------**

4.2 All rights, interests, liabilities, obligations, risks, costs, expenses and pecuniary obligations and all net profits or net losses arising out of the **Contract** shall be shared or borne by the **Parties** in the above **Proportions**.

4.3 The members in the proportion as mention in article 4.1, shall contribute sufficient Initial fixed capital for timely execution of the project including commissioning & operating period as per the contract.

ARTICLE 5: JOINT EFFORT AND MANAGEMENT:

5.1 The **Parties** shall participate as a **JV** in the submission of bids and further negotiations with the **Employer** and shall co-operate and contribute their respective expertise and resources to secure and execute the **Projects**.

5.2 On award of **Projects**, the **First Partner** in consultation with the other members of JV will decide on the final management structure for the successful execution of the **Projects** as per the terms of **Contract**.

5.3 All the **Parties** hereby agree to pool in their financial, administrative, managerial, technical and material resources for execution of the **Projects**, including commissioning & operation for the period as stipulated in the contract. The share of interest of the **JV** shall be as per the mutual understanding for the successful completion of the project.

ARTICLE 6: EXCLUSIVITY:

6.1 The co-operation between the **Parties** hereto shall be mutually exclusive i.e. none of them shall without the other **Party's** consent & prior approval of **USCL**, approach or cooperate with any other parties in respect of the Project.

6.2 In the course of working as associates, the parties to the JV will be sharing information with each other which may be proprietary /confidential information /knowledge acquired by each other. It is hereby agreed that the parties will maintain complete secrecy regarding such information / knowledge and will not divulge to any party for any other purpose except for the success of the joint execution of the contract. All parties will also indemnify each other against any claim that may arise out of using information, which are being claimed proprietary.

ARTICLE 7: Memorandum of Understanding:

7.1 This **Memorandum of Understanding** shall be terminated:-

a. if the **Parties** mutually confirm that the **JV's** bid proposal has not been finally accepted by **Employer** and all rights and obligations of the **Parties** under or in connection with this **Memorandum of Understanding** have ceased, or

b. after successful completion of the project including commissioning & operation and defect liability period from the date of this **Memorandum of Understanding** unless extended for a further period on demand of **USCL** & mutual consent of the Parties, or

7.2 The **Memorandum of Understanding** can be modified by mutual consent of the Parties to suit the efficient and expeditious execution of Projects including commissioning & operation of Plant or to make this agreement more meaningful to suit the requirements of Employer **after the consent of the Employer**.

ARTICLE 8: ARBITRATION:

8.1 Any dispute resulting from this Agreement shall be settled amicably by mutual Consultation by the Managing Directors/Chairman of _____&_____. In the event that an amicable settlement is not reached within 60 days in any particular case, the dispute shall be referred to arbitration and shall be resolved in accordance with and subject to the provisions of the _____ and any statutory modifications and enactment hereof for the time being in force. The decision of the arbitrators shall be final and binding upon both parties. The venue of arbitration will be _____.

ARTICLE 9: GOVERNING LAWS:

9.1 This Agreement shall in all respects be governed by and interpreted in accordance with the _____ Laws.

ARTICLE 10: CONFIDENTIALITY:

10.1 No Party hereto shall disclose to any other party any information of a confidential nature including but not limited to trade secrets, know-how acquired from any Party in connection with the subject matter of this Agreement.

ARTICLE 11: ADDRESS OF CONSORTIUM:

Any and all correspondence from the Employer to the **JV** shall be addressed to **(name of JV)** at the address stated herein below–(any one of the partners). The address of the Consortium office of the partner companies will be deemed to be the address for the purpose of communication.
The notice, if any required to be served on the party by the other party, will be deemed to be served, if the said notice / communication is delivered by Registered Post at the respective address **(name of JV)**

_____
_____

ARTICLE 12: Authorized Representative:

The JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the JV during the bidding process and, in the event the JV is awarded the Contract, during contract execution.
Authorized Representative of JV: _____

ARTICLE 13: ASSIGN ABILITY:

13.1 The interests and rights of a Party in the Contract and as a Party of the Joint Venture shall not be transferable or assignable without the written consent of the Employer & other party.

ARTICLE14: INTERPRETATION OF HEADINGS:

14. The headings of each of the Articles herein contained are inserted merely for convenience of reference and shall be ignored in the interpretation and construction of any of the provisions herein contained.

ARTICLE 15: OTHERS

15.1 Any other matters not contained in this Agreement shall be discussed and amicably agreed upon by the Parties in the spirit of mutual trust and cooperation for timely completion of project including commissioning & operation of project. Notwithstanding anything above all the Parties are severally and jointly responsible to the Employer for execution of the Contract:

IN WITNESS WHEREOF the Parties hereto have caused this Agreement to be executed by each of the duly authorized representatives as appearing below:-

Signed by)
For and on behalf of
_____ **)**

in the presence of:)
_____
Name:
Designation:

_____
Name:
Designation:

Signed by)
For and on behalf of)
_____**.**

in the presence of:)
_____)
Name:
Designation:

_____
Name :
Designation:

4.8 Bidding Capacity

4.8.1 STATEMENT FOR WORK IN HAND (for calculation of value of B)

This is to certify that the status of the present works in hand as on **date of publication of NIT** of order value more than Rs. 100.00 lacs for which either order are received or the work is under execution but which are still not completed is as under:

Amount In Lac Rs.

S. No	Brief Description of Work	Stipulated Date of Start	Stipulated Date of Completion	Time left for execution after **date of publication of NIT**, in months	Cost of awarded work	Cost of work executed up to **date of publication of NIT**	Balance Cost of un-executed work as on **date of publication of NIT in 30 month from and date of submission**
1	2	3	4	5	6	7	8=6-7

1. If the value of Balance work goes beyond 30 months from the date of bid submission then client certificate mentioning the amount of work to be executed beyond 30 months, otherwise full balance work shall be accounted for calculation of 'B' value.

*2. This is certified that this is true in all respect and can be used for calculation of the bidding capacity as per the formula given in ITB. This is also certified that other orders under execution by the firm shall not materially affect the bidding capacity of the firm as required in this tender**. (Format should be on Rs 500/= stamp paper)***

Signatures With Seal of Authorized Signatory for tender

4.9 Check Points must be filled by Bidder

S. No.	Requirements / Documents required to be submitted		Check Points	Yes / No	Enclosed at page no. of bid and any other detail as required
	GENERAL				
1	Cost of Bid Document as Rs. 100,000/-	DD/Cheque in favour of Chief Executive Officer, Udaipur Smart City Limited, Original hard copy to be submitted in the office of Chief Executive Officer, Udaipur Smart City Limited by date and time mentioned in NIB and scanned copy to be uploaded with technical bid	Confirm it is of scheduled bank ? Name of Bank		
			Amount Rs. 100,000.00		
			In favour of Chief Executive Officer, Udaipur Smart City Limited		
2	Bid Processing Fee of Rs 1,000/-	DD/Cheque in favour of MD, RISL, Original hard copy to be submitted in the office of Chief Executive Officer, Udaipur Smart City Limited by date and time mentioned in NIB and scanned copy to be uploaded with technical bid	Confirm it is of scheduled bank? Name of Bank		
			Amount Rs. 1000.00		
			In favour of MD, RISL		
3	Bid Security at 2% of estimated procurement cost In case of JV, the Bid Security must be in the name of all partners to the Joint Venture / Lead bidder that submits the bid. **Should be valid up to** _____	DD / Bankers Cheque / Bank Guarantee as per format, Original hard copy to be submitted in the office of Chief Executive Officer, Udaipur Smart City Limited by date and time mentioned in NIB and scanned copy to be uploaded with technical bid	Confirm that as per format?		
			Confirm that it is in prescribed format? If not, liable to be rejected.		
			Confirm that it is unconditional? If any condition bid liable to be rejected.		
			State in whose name is bid security (JV or Lead Bidder)		
			BG number		
			Confirm that BG is Valid up to 30 days beyond the validity of bid		
			Confirm it of a scheduled bank? Mention the Name of bank. Amount		
4	Power of Attorney	On Stamp Paper, Original hard copy to be submitted in the office of Chief Executive	Confirm that value of Stamp Paper is Rs. 500/-		

S. No.	Requirements / Documents required to be submitted		Check Points	Yes / No	Enclosed at page no. of bid and any other detail as required
		Officer, Udaipur Smart City Limited by date and time mentioned in NIB and scanned copy to be uploaded with technical bid	Name & designation of person who has issued POA		
			Name & designation of person to whom POA is issued		
5	Joint Venture Agreement	Agreement/ Notary as per format (not more than four companies) Original hard copy to be submitted in the office of Chief Executive Officer, Udaipur Smart City Limited by date and time mentioned in NIB and scanned copy to be uploaded with technical bid	Confirm that value of Stamp Paper is Rs. 1000/-		
			Confirm that financial responsibility of lead partner is minimum 51%		
			Confirm that financial responsibility of other partner bidder is minimum 15%		
			Confirm that JV is in prescribed format. If not, liable to be rejected.		

4.10 SELF APPRAISAL SHEET TO BE FILLED BY THE BIDDER FOR DETERMINATION OF RESPONSIVENESS

S. No.	Requirements as per bid document	Check points	Tick the correct option or fill in information	Enclosed at page no. of bid and any other detail as required
	General Requirements			
1	VAT Registration /clearance certificate	Confirm that submitted	Yes / No	
2	VAT/GST Registration in Rajasthan	Confirm that submitted with this bid or will be submitted later	Yes / later after award	
3	PAN & TAN Numbers	Confirm that submitted	Yes / No	
	Eligibility Criteria			
4	Nationality - Indian/International firms	Specify nationality	Indian/International	
5	Declaration Requirement to be fulfilled by:Each of the consortium / JV member	Confirm that declaration submitted by bidder / each partner in case of JV	Yes / No	
		Confirm that it is in the prescribed format. If not, bid is liable to be rejected	Yes / No	
6	Declaration regarding Debarment/Transgression by any procuring entity Requirement to be fulfilled by: Each of the consortium / JV member	Confirm that declaration submitted by bidder / each partner in case of JV	Yes / No	
		Confirm that it is in the prescribed format; If not, bid is liable to be rejected	Yes / No	
7	Pending Litigation in Form LIT-1 - All pending litigation shall be treated as resolved against the bidder and so shall in total not represent more than 50 percent of Bidder's net worth Requirement to be fulfilled by: Each of the consortium / JV member	Confirm that declaration submitted by bidder / each partner in case of JV	Yes / No	
		Confirm that it is in the prescribed format; If not, bid is liable to be rejected	Yes / No	
		Confirm that value of litigations is less than 50% of bidder's net worth and CA certificate showing calculation	Yes / No	
8	Should have substantially completed at least one contract that has been successfully or substantially completed with 60% of the component value	Number of works on basis of which eligibility is claimed.		
		Details of qualifying works : **Work no. 1**		
		Name of work (in brief)		
		Name of client		

S. No.	Requirements as per bid document	Check points	Tick the correct option or fill in information	Enclosed at page no. of bid and any other detail as required
	within the last **10 (Ten)** years and that is similar to the proposed works;	Value of work done		
		value of work done by bidder in case work is carried out in JV		
		Stipulated Date of start (as per work order)		
		Stipulated Date of completion (as per work order)		
		If completed & commissioned, indicate Actual date of completion & commissioning (as per client's certificate). Confirm that this date is after 31.3.10.		
		Confirm any one of the following: i. Work is completed and commissioned ii. works is completed but could not be commissioned because of hindrances beyond control of contractor iii. Work is completed and commissioned at least of the amount required for qualification, out of large size contract.		
		Similar information to be given for each work if work done is more than one		
9	Form FIN-2 - Net Worth in last financial year (Financial Year 2015-16) should be positive**.** The calculation sheet for annual net worth shall be certified by a Chartered Accountant.	Confirm that Certificate of Chartered Accountant for last financial year and calculation of net worth, attached; If not, bid is liable to be rejected		
		Indicate value of net worth		
10	Form FIN-2 - Average Annual Turnover of last three financial years (Financial Year 2014-15 to 2016-17) should be equal to or more **INR 480 Crore.** The calculation sheet for annual average turnover shall be certified by a Chartered Accountant. In case of JV, lead member should meet 60 percent of the requirement	Confirm that Certificate of Chartered Accountant for each financial year and calculation of average value at present price level, attached; If not, bid is liable to be rejected		
		Indicate value of average annual turn over		

S. No.	Requirements as per bid document	Check points	Tick the correct option or fill in information	Enclosed at page no. of bid and any other detail as required
11	**Working Capital:** Working Capital based on the current assets and current liabilities (including the short term loan repayments due in current years) should be **INR 120 Crore (**25% of the estimated cost of bid). (Available working capital should be evaluated as current assets + revolving line of credit – current liabilities including loan repayments due within one year).	Confirm that Certificate of Chartered Accountant for last financial year		
		Indicate value of working capital based on formula		
12	Bid capacity	Confirm that affidavit of bid capacity submitted on Stamp Paper of Rs. 500.00		
		Confirm that certificate of CA submitted for Bid Capacity clearly showing calculation; If not, bid is liable to be rejected		
		Value of A		
		Value of B		
		Bid Capacity		
		Confirm that bidder has mentioned in affidavit that all works above Rs. 10 lakhs, to be completed in next 30 months (period of completion + bid validity period), required for determination of value of “B” are declared		
		Confirm that bank’s letter submitted for revolving line of credit, If required		
		Confirm that the above bank’s letter is as per format;		

Section-V: Procuring Entity's Requirements

SECTION V
EMPLOYER'S REQUIREMENT

2.0. Preamble

The Smart Cities Mission of the Government is a bold new initiative. The objective of the Smart Cities Mission (SCM) is to develop cities with core infrastructure and decent quality of life for its citizens, a clean and sustainable environment and application of "Smart" Solutions. The focus of the Mission is on sustainable and inclusive development, aiming to drive economic growth and improve the quality of life of people by enabling Area Based Development (ABD) through development, rehabilitation, retrofitting and redeveloping of the infrastructure. Application of Smart Solutions will enable cities to use technology, information and data to improve infrastructure and services. This sort of a comprehensive development is expected to improve the quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive Cities. It is also meant to set examples that can be replicated both within and outside the Smart City, catalyzing the creation of similar Smart Cities in various regions and parts of the country.

Udaipur is a major city, municipal corporation and the administrative headquarters of the Udaipur district in the Indian state of Rajasthan. It is the historic capital of the kingdom of Mewar in the former Rajputana Regime. Maharana Udai Singh of the Sisodia clan of Rajput founded the city in 1553 and shifted his capital from the city of Chittorgarh to Udaipur. It remained as the capital city till 1818 when it became a British princely state, and thereafter the Mewar province became a part of Rajasthan when India gained independence in 1947. Udaipur is a very popular tourist destination. Known for its history, culture, scenic locations and the Rajput-era palaces. The total population of the town amounts to approximately 451,735 inhabitants, as per Census 2011.

The Municipal Corporation of Udaipur (MCU), as part of the Udaipur Smart City Project being executed through Udaipur Smart City Limited (USCL), proposes to provide Integrated Infrastructure to the 828 acre (3.4 km^2) of the Walled City (Area Based Development) which is the city core, comprising 5% of municipal area and housing 20% population of the city.

2.1. Project Components

The components of the Udaipur Integrated Infrastructure Project are detailed below;

1. Design, Rehabilitation, Up-gradation and Construction of water distribution network and domestic 24X7water supply in ABD area of Udaipur city;
2. Design, Rehabilitation, Up-gradation and Construction of sewerage network in ABD area;
3. Design, Undergrounding of power, telecom and other cables along with Rehabilitation, Up-gradation and Construction of power distribution network and domestic connections across core area of Udaipur city;
4. Design and Construction of Utility duct across core area of Udaipur city; and
5. Design and Relaying of Roads & Drain in ABD area of Udaipur City.
6. Design Supply and Installation of SCADA system in ABD area of Udaipur City.
7. Operation and Maintenance for Ten (10) years of each component after its execution.

2.2. Need of the Project

Udaipur currently faces serious Infrastructure challenges even at city level, besides a greater need in walled city of Udaipur. The Walled city was developed about 500 years back and all basic infrastructure i.e. water, sewerage and power has been developed in a piece meal basis and that too more than 20-30 years back. The need for an integrated infrastructure project could be substantiated due to following factors:

1. Existing Infrastructure is aging with time and could collapse in very near future
2. A piece meal approach of implementation and operation has been adopted till date
3. With change of living practices, the need for a state of the art infrastructure becomes essential
4. An integrated yet cutomised, need of the citizens living in walled city, is required

5. During implementation, citizen convenience shall be given highest importance for this brownfield development
6. Heritage and cultural ethos are also of significant practice for such development, especially for all above ground infrastructure components

2.3. Project Phases

The Udaipur Integrated Infrastructure Project shall be implemented in following phases:

Phase	Particular	Duration
I	Design and Approval	6 Months
II	Construction of Integrated Utilities in ABD Area	18 Months
III	Final Acceptance & Testing	6 Months
IV	Operation & Maintenance	10 Years

The Selected Bidder shall require to work in a sequential but integrated manner to ensure highest standard of infrastructure delivery in this very critical walled city area. It shall also be responsible for all activities during the complete contract period of 13 years (3+10). At no point during the Contract Period, the Selected Bidder would be absolve of its responsibilities as defined in the Contract document.

2.4. Project Timelines

The Project shall be implemented as defined broadly, the chart below:

	H1	H2	H3	H4
Water Supply				
- Design & Approval				
- Construction activity				
- Final Acceptance & Testing				
Sewerage				
- Design & Approval				
- Construction activity				
- Final Acceptance & Testing				
Power				
- Design & Approval				
- Construction activity				
- Final Acceptance & Testing				
Multi-utility Duct				
- Design & Approval				
- Construction activity				
- Final Acceptance & Testing				
Road relaying & Drains				
- Design & Approval				
- Construction activity				
- Final Acceptance & Testing				
SCADA				
- Design & Approval				
- Construction activity				
- Final Acceptance & Testing				

**H1, H2, H3 is half years and activities starts from date of signing of the Contract*

The construction of components are to be completed within **Two (2) years** followed by **Operation and Maintenance of all the Six (6) components for Ten (10) years.**
Present Status, Scope of work, Technical Specifications, Sector Specific Conditions and Performance Parameters are provided as below:

2.0. Present Status of Utilities in the Walled City

2.1. Water Supply

Public Health Engineering Department (PHED), Government of Rajasthan is responsible for planning, designing, construction, operation, and maintenance of the water supply system. Water supply scheme of Udaipur city is headed by the Additional Chief Engineer, Udaipur Region. The city is divided into two (02) divisions each headed by an Executive Engineer. Further, division 1st has 4 sub-divisions and division 2nd has 3 subdivisions each headed by an Assistant Engineer. Service level, in terms of potable water supply, is poor and major part of the town receives alternate day water supply.

Pichhola and Fatehsagar lakes in Udaipur are the major source of surface raw water for Udaipur city including ABD area. Other than these two lakes, the city also receives surface water from Jaisamand lake, Mansi Wakal Project Phase-I and Dewas Phase-I & II projects. The source of raw water for ABD area shall be primarily Pichhola Lake.

In the walled city area / ABD the distribution system is very old and was first laid in the 1950s and the pipe material was Cast Iron and Asbestos Cement Concrete. Subsequently PVC pipes were used at many places. The old distribution system leads to leakages and sudden breakdowns frequently. The PHED is slowly phasing out use of AC and PVC pipes and at many locations these have been replaced with DI pipes. The distribution system size ranges from 80 mm to 600 mm. Due to undulating topography of the city, there are many low-pressure points affecting the water supply pressure at consumer end.

The foundation for water supply scheme was laid in the year 1950. Raw water from Lake Pichola was drawn by constructing a Pumping Station at Dudh Talai in Lake Pichola and pumped to Water Treatment Plant at Gulab Bagh. After treatment the clear was is pumped to GLSR constructed on the Hillock at Machla Magra so as to create sufficient head for supplying water to the Udaipur city including ABD area by gravity. However, with the passage of time and as the city expanded outwards (around ABD area) new raw water sources and water treatment plants and distribution infrastructure was created but the major source of water supply for ABD area remains Gulab Bagh WTP.

Presently, four Water Treatment Plants (WTPs) supplies water in ABD Area. Their details and capacities are provided in following table:

S. No.	Name of WTP	Peak Capacity
1.	Dudh Talai WTP	13.5 MLD & 2.85 MLD
2.	Gulab Bagh WTP	4.54 MLD & 2.27 MLD
3.	Patel Circle WTP	7.5 MLD
4.	Fatehsagar WTP	3.4 MLD & 1.72 MLD

The raw water supply to Dudh Talai, Gulab Bagh and Patel Circle WTPs is being done from Raw Water Pumping Station (RWPS) located in Lake Pichola at Dudh Talai.

The details of existing pumping machinery installed at Dudh Talai RWPS are mentioned below:

S. No.	Pumping raw water to WTP	Pump duty condition	Rising main emerging from RWPS
1.	13.5 MLD at Dudh Talai	a. 341 m3/hr @ 62 m (1W+1S) b. 675 m3/hr @ 60 m (1W) c. 288 m3/hr @ 62 m (1W) d. 340 m3/hr @ 62 m (2W) e. 350 m3/hr @ 60 m (S)	300 mm & 450 mm Dia.
2.	2.85 MLD at Dudh Talai	a. 141 m3/hr @ 55 m (2W + 1S)	300 mm Dia CI.
3.	4.54 MLD & 2.27 MLD at Gulab Bagh	a. 250 m3/hr @ 30 m (1W + 1S)	300 mm Dia CI.
4.	7.5 MLD at Patel Circle	a. 381 m3/hr @ 40 m (1W + 1S) b. 191 m3/hr @ 30 m (1W + 1S)	600 mm Dia CI.

Distribution system from Dudh Talai WTP to ABD area

Clear water from Dudh Tala WTP is stored in common CWR of capacity 3.6 ML. water from this CWR is than distributed to distribution network by 2 nos. Cast Iron gravity mains of 300 mm dia and 450 mm dia. 450 mm dia feeder goes directly into distribution whereas the 300 mm dia feeder first feeds into 2 OHSRs whose details are given below and from there the water goes into distribution system

S.N.	OHSR	Capacity (KL)
1.	Purohito Ki Haveli	350
2.	Kanwar Pada School	500

Distribution system from Gulab Bagh WTP to ABD area

Clear water from Gulab Bagh WTP is stored in CWR from where water is pumped from pump house at Gulab Bagh to 2 nos GLSR at hillock of Machla Magra (Low Zone and High Zone) and OHSR at MB College (700 Kl) and Town Hall (500 Kl). Water from low zone and high zone GLR is fed directly into the distribution network of ABD area.

Distribution system from Fatehsagar WTP to ABD area

A small portion of ABD area is covered under this system consisting of Bhrampole and Chandpole. One part Clear water from Fatehsagar is pumped to Ambav Garh GLSR from where water is send directly into distribution.

Existing distribution system network and house service connection in the ABD area

The existing diameters and pipe material of the distribution network in ABD area are detailed below in the Table:

SN.	Pipe material	Diameter (mm)	Length (m)
1	AC	80	9906
		100	6352
		200	3892
		300	1040
		Total Length	**21,190**
2	CI	80	5646
		100	6262
		150	5847
		200	4458
		225	1234

SN.	Pipe material	Diameter (mm)	Length (m)
		250	2144
		300	3897
		350	1189
		Total Length	**30,677**
3	DI	100	20355
		150	9133
		200	3183
		250	2144
		450	1226
		Total Length	**36,041**
Total existing distribution system length =			**87,908**

Details of House Service Connection

SN.	Connection type	Connection size (mm)	Approximate nos.
1.	Domestic	15	19035
2.	Commercial	20	150
3.	Industrial	25	50
		Total =	**19,235**

Operation and maintenance

PHED is overall responsible for maintenance of water supply system in Udaipur city. Additional CE PHED is the overall in-charge supported by one Superintending Engineer and 2 Executive Engineers.

As per record of technical staff on pay rolls of PHED, new hiring has been stopped since last few years& maintenance work is being done through repair and O&M contracts. Maintenance of distribution system & pumping operation in large parts of Udaipur is given on operations contract. These contracts are not linked to performance and the contractors have low skill sets.

Existing Conditions of Consumer meters

The situation of water consumer metering is very poor in project area. The major constraint in proper installation of water meters is lack of adequate space in households, multiple connections in single building, absence of right of way etc.

A large numbers of water meters are damaged and non-functional. Moreover, due to unprotected meters, large numbers of meter have no readable faces. The house service lines are mostly of PVC and are liable to be damaged and become a potential source of pollution besides water leakages. A large number of consumers resort to illegal use of online boosters.

Existing service level parameters

The water supply indicators for Udaipur city are mentioned below:

Service Level Indicator	Unit	Nos.
Household level coverage of direct water supply connections	%	95
Rate of supply	Lpcd	80
Metered connections	%	70
NRW	%	40

Service Level Indicator	Unit	Nos.
Water supply duration	Hrs	1 hr alternate days
Efficiency in addressing customer complaints	%	80
Water quality	%	95

2.2. Sewerage

The entire Udaipur City is not fully covered by an integrated underground sewerage system. The old system is in worn out condition due to completion of its design life. Only the area covered by UIT has workable sewer system which is new in some of the area and the work of sewer line is under progress. At present, the city has a skeleton existing sewerage system, which covers the high density populated areas of the walled city. Very sparse old sewerage system in the catchment areas of the lakes consist of only 3,500 meters of sewers varying in diameters from 150-350 mm covering a population of about 10,000 in Ambamata, Brahmapuri, Lalghat, Navghat, and Chandpole area. The sewage from these sewers used to flow by reaping up to Jhatwadi by a pump-house located at Chandpole (ridgeline) from where it was gravitating to Hathipole through 400 mm diameter gravity sewers.

The existing sewerage system spreads in limited area of 13 wards out of 55 wards of Municipal area of Udaipur i.e. ward nos. 22, 33 to 37, 42 to 47 & 50 with an outfall of 800 mm diameter at Manwa Kheda at a distance of 4.5 km from City.

Besides this, UIT Udaipur took the execution of sewerage project to protect lake Pichola from pollution. Sewage generated from the area Mallatalai, Haridasji Ki Magri, Ambamata Scheme, Raja Colony, Yadav Kachi Basti, Bagore Ki Haveli, Purohit Ji Ki Haveli, Brampole, Gangor Ghat, Lalghat, Gadia Deora etc. gravitate to Hathipole through 800 mm diameter sewer line from where it is carried by existing sewer line already functional from Hathipole to Manwa Kheda. There is one pumping station near Hanuman Temple in Ambamataa area because of some low lying areas such as Yadav Kachi, Basti, Ambavgarh, part of Ambamata scheme etc. In this area, the main sewer line runs from Mallatalai to Hathipole via Chandpole. The sewer line is telescopic with starting diameter of 500 mm to 800 mm at Hathipole. Part of this sewer line has been laid in the bed of Lake Pichola. The ductile Iron (800 mm) pipe line has been laid in the lake bed. Along with a network of 24 km sewer, about 3,400 sewer house connection have been done simultaneously.

Sewerage System constructed by PHED

Initially PHED introduced the Sewerage System in the city and they constructed sewerage network for 84.2 Ha area in the Walled City in the year 1976-78. The total length of the network is 21.5 km and has approximately 5,000 house service connections. The colonies or areas served by the PHED scheme are: Chand Pol Area, Shivaji Nagar, Ganesh Ghati, Shakti Nagar, Bhupal Wadi, Ashok Nagar, Delhi Gate, Subhash Nagar, Hathi Pol, Hiran Magri Sector-3.

The trunk sewer of the above sewerage system starts at Suraj Pol and drains into River Ahar at Manwakheda. The size of pipes in the sewerage system ranges from 150 mm to 300 mm and the size of the trunk main ranges from 400 mm to 800 mm. This system is in highly degraded condition, therefore whole area has been proposed for new sewer line.

Sewerage System constructed by UIT

The Udaipur Improvement Trust (UIT) built sewerage system of 23.5 kms length for the areas around the lakes in the year 2002-04, to avoid untreated sewage being discharged in to the lakes. The sewerage network built under this scheme covers peripheral areas of lake Pichola as well as internal areas like Delhi Gate, Chandpole, etc. Approximately 6,000 house service connections are provided through this system. The size of sewer is 150 mm only and therefore frequent overflows are observed in the UIT area. Main areas covered by the above scheme are as follows: Hari Das Ji Ki Magri, Ambamata, Malla Tallai,Brahm Pol Area, Amber Mata, Brahm Pol Magri, Amber Garh, Left side area of Rang Sagar lake, Guni Dayal Marg Naga Magri.

UIT constructed this sewerage system in two phases. In first phase, it covered an area of 144 Ha around the lakes, which includes the colonies like Ambamataa, Chandpole, city palace area, fateh palace area etc. In the second phase UIT covered an area of 212 Ha which includes the colonies like malla thalai, ekalavya colony, Raza colony, Amar Nagar, Kaimi Ekta Nagar,Pragati Nagar etc. There are total 17 Sewage Pumping and Lifting Stations and the length of the pumping mains is 6.9 km.

The existing trunk line from Hathipole to Manwa Khera is not sufficient to bear the heavy load of sewage from these areas. In the year 2013-16, UIT with assistance of Hindustan Zinc Limited, laid a 7,78 KM trunk line of diameters varying from 800 mm to 1,400 mm for conveying the waste water to STP of 20 MLD capacity at Ekingpura. This STP was based on MBBR technology and was constructed in the year 2013-16 with assistance from Hindustan Zinc Limited.

Disposal of Sewage

The entire sewage generated in the city finds its way to Ayad River through 800 mm diameter outfall sewer at Manwa Kheda village. Congested parts of the city areas have extensive network of surface water drains, to which wastewater from houses (including water closets) is directly connected. The surface water drains ultimately discharge into lakes causing lake pollution. There has been an arrangement to collect and convey sewage from community septic tanks at various locations up to nearest natural or constructed drains.

Existing Trunk Line

The existing trunk sewer starts at Mallatallai with 500 mm diameter. The alignment of the trunk sewer passes through Brahmpole Marg, Swaroop Sager Lake and Hathi Pol. The diameter of the trunk sewer increases from 500 mm to 700 mm at Jethion-Ki-Bari and continues with the same diameter up to Brahmpole Gate where, the size of the trunk increases to 800 mm and continues up to Hathi Pol. The above trunk line joins another trunk line laid in 1971 by PHED, which goes all the way up to Manwa Kheda.

Situation Analysis of Existing Sewerage System

Major deficiencies in the existing sewage collection system are listed below:

(a) Inadequate coverage with insufficient capacity and worn condition

The sewage collection system is not laid to cover all areas of the city. In fact it does not fully cover even the areas for which branch and main sewers have been laid. The sewers laid by PHED by more than 30 years old therefore they have completed the design life, hence complete old system has been proposed to be replaced with new system. In UIT area which has been laid in 2005 has not covered the complete area. The size of sewer is 150 mm, therefore facing the frequent over flow problem. Out of total line of 23.5 km in UIT area, 15.52 km is 150 mm sewer, therefore during the design, it has been proposed to replace the system with 200 m dia, but the replacement has been proposed in II phase of project. All the ongoing sewer in UIT area has been retained the comprehensive sewerage project and integrated with the design.

Presently the sewerage coverage population wise is 10% only through sewers laid by PHED (21.5 kms in the year 1976-78) and UIT (23.5 kms in the year 2002-04). Total House service connections are 11,000 Nos.

In order to increase the coverage various projects have been launched and undertaken under various schemes. These works are as follows:

It is estimated that after completion of these projects around 60.67% of the population coverage for sewerage could be achieved. Population coverage details shall be as follows:

S. No.	Particulars	%age
1.	Sewerage System laid by UIT & PHED	10%
2.	Sewerage Projects undertaken under NLCP	10.3%.

3.	Sewerage Project under AMRUT Phase I	18%
4.	Sewerage Project under AMRUT Phase II	7.4%
5.	Sewerage Project under Smart City Mission	12%
6.	Sewerage Works under RUIDP	4.97%
	TOTAL	62.67%.

House Connections

Except the area in which UIT has laid sewer lines does not have house connections, without which the sewer lines cannot function properly. Only about 19000 old sewer connections exist in the entire city as against 75,183 households as per census 2011 therefore all the remaining houses have been proposed to be connected with property connections.

2.3. Power

There are six 33/11 KV GSS, 4 are old and 2 are newly constructed, who feeding the power to wall city through overhead primary and secondary distribution network. the distribution transformer has mount on pole, the output LT power from the distribution Transformer to feed LT Network which is also overhead, the connected consumers (residential, commercial and industrial) of wall city is approximate 30 thousand consumer they access power by service cable through nearest overhead LT supply on pole. The power consumption of wall city is 86.9 Mega units. The AT&C losses is 11

2.4. Multi-utility Ducts

The Multi-utility Duct is relatively a new concept for the state and no such project has yet been executed in the City.

2.5. Roads & Drains

The walled city has reasonably good quality road infrastructure with following specifications:

S. No	Width of Road	Length (Km)
1	0.5< RW<2	43
2	2<RW<3	22
3	3<RW<5	22
4	5<RW<8	5.34
5	8<RW<12	2.36
6	12<RW<15	4.88
Total Length		**99.58**

Existing road civil works:

Layers	ROAD Width	AVG Width	Road Type		Existing Area (sqm) B.T		Thickness	Total quantity in Cum/Sqm/ Running meter
			B.T. (km)	C.C. (km)	B.T.	C.C.		
PQC	0.5< RW<2	1.25		43		32250	0.15	8062.5
WBM	0.5< RW<2	1.25		43		53750	0.075	4031.25
Dismantling	0.5< RW<2	1.25		43		53750	0.15	8062.5

Layers	ROAD Width	AVG Width	Road Type		Existing Area (sqm) B.T		Thickness	Total quantity in Cum/Sqm/ Running meter
			B.T. (km)	C.C. (km)	B.T.	C.C.		
PQC	2<RW<3	2.5		22		55000	0.15	8250
WBM	2<RW<3	2.5		22		55000	0.075	4125
Dismantling	2<RW<3	2.5		22		55000	0.15	8250

Layers	ROAD Width	AVG Width	Road Type		Existing Area (sqm) B.T		Thickness	Total quantity in Cum/Sqm/ Running meter
			B.T. (km)	C.C. (km)	B.T.	C.C.		
PQC	3<RW<5	4	22		88000		0.18	15840
WBM	3<RW<5	4	22		48400		0.075	6600
Dismantling	3<RW<5	4	22		48400		0.09	7920

Layers	ROAD Width	AVG Width	Road Type		Existing Area (sqm) B.T		Thickness	Total quantity in Cum/Sqm/Running meter
			B.T. (km)	C.C. (km)	B.T.	C.C.		
BC	5<RW<8	6.5	5.34		34710		0.04	1388.4
DBM	5<RW<8	6.5	5.34		15486		0.05	1735.5
SEAL COAT	5<RW<8	6.5	5.34		15486			34710
PRIME COAT	5<RW<8	6.5	5.34		15486			34710
TACK COAT	5<RW<8	6.5	5.34		15486			34710
Dismantling	5<RW<8	6.5	5.34		15486		0.09	3123.9

Layers	ROAD Width	AVG Width	Road Type		Existing Area (sqm) B.T		Thickness	Total quantity in Cum/Sqm/ Running meter
			B.T. (km)	C.C. (km)	B.T.	C.C.		
BC	8<RW<12	10	2.36		19352		0.04	944
DBM	8<RW<12	10	2.36		15104		0.05	1180
SEAL COAT	8<RW<12	10	2.36		15104			23600
PRIME COAT	8<RW<12	10	2.36		15104			23600
TACK COAT	8<RW<12	10	2.36		15104			23600

Dismantling	8<RW<12	10	2.36		15104		0.09	2124

Layers	ROAD Width	AVG Width	Road Type		Existing Area (sqm) B.T		Thickness	Total quantity in Cum/Sqm/Running meter
			B.T. (km)	C.C. (km)	B.T.	C.C.		
BC	12<RW<15	13.5	4.88		48312		0.04	2635.2
DBM	12<RW<15	13.5	4.88		48312		0.05	3294
SEAL COAT	12<RW<15	13.5	4.88		48312			65880
PRIME COAT	12<RW<15	13.5	4.88		48312			65880
TACK COAT	12<RW<15	13.5	4.88		48312			65880
Dismantling	12<RW<15	13.5	4.88		48312		0.09	5929.2

A detailed road map is provided in Annexure.

The quality of roads is generally bitumen except few road sections are built with Cement Concrete.

There are 51 Major Intersections and 10 Minor Intersections in the walled city. The details are as below:

Sl. No	Name of Major Intersection	Type	Area (sqm)	Sl .No	Name of Intersection	Type	Area (sqm)
1	Gayatri kiryana	Y	370	27	Mukharji chowk	+	220
2	No name	T	70	28	Jagadish chowk	Multy legged	90
3	Prerna playway school	4legged (Y & T)	450	29	Jagadish temple intersection	Multy legged	360
4	Hathipole gate	Multy legged	2850	30	Ziniret chowk	+	100
5	Pyau	T	100	31	Shreeji remedies	Multy legged	765
6	Raja chowk	4 legged	80	32	Suraj pole	Multy legged	4200
7	Police chowk	Staggered	150	33	Hotel new jyoti	T	950
8	Chhatrio ko chowk	T	220	34	Gulab bagh road chawrastha	Staggered	675
9	Jodhpur misthan	+	550	35	Police station suraj pole chawarstha	Multy legged	1000
10	Delhi gate	Multy legged	2600	36	Pichhori mohalla	Staggered	260
11	Bapubazar1	Y	300	37	Hotel moti mahal	+	180
12	Bapubazar2	4 legged	800	38	Udiyapur bus station chawrasta	Multy legged	5000
13	Bapubazar3	Y	500	39	Vishwakarma travels	Multy legged	200
14	Bapubazar4	4 legged	1400	40	Kalaji goraji temple	X	750
15	Chokhala bazar	Multy legged	65	41	Hotal gulabbag	+	1300

Sl. No	Name of Major Intersection	Type	Area (sqm)	Sl .No	Name of Intersection	Type	Area (sqm)
16	Nalwaya chowk	Multy legged	150	42	Gold leaf hotel	T	250
17	Bhram pole	+	180	43	City palace area	Y	250
18	Ishwar niwas	Y	100	44	Hotel pannadhay palace	Multy legged	370
19	Jagnath marg	4 legged	180	45	Ranga niwas palace hotel	T	240
20	Ganesh ghati	+	50	46	Bhairu ji temple	4 legged	260
21	Clock tower	Staggered	550	47	Roshan lal sharma public ses. School	+	80
22	Nichla mochiwara	4legged intersection (Y&T)	160	48	Khanaji peer chawrasta 2	Staggered	225
23	Lakhara chowk	Staggered	50	49	Doodh talai	T	170
24	Bapubazar5	Multy legged	1600	50	khanaji peer chawrasta 1	T	960
25	Queen café restaurant	+	30	51	Rajja chowk (Patel circle)	Y	5000
26	Pandu wara	X	120				

Sl. No	Name of Minor Intersection	Type	Area (sqm)	Sl. No	Name of Intersection	Type	Area (sqm)
1	Ahriant foma center	4 legged	180	6	Mathon ki sahri	T	70
2	Bulakika chowk	Multy legged	110	7	Khairwada hanuman chowk	X	80
3	Vyas bhawan	Staggered	225	8	Mahaveer bhavan chowk	T	100
4	Nathi ghat chowk	Staggered	40	9	Naiyon ki talai	Y	600
5	Madhan mohan mathuradhish temple	Y	70	10	Gopal bhavan	X	120

3.0. Project objectives:

The Integrated Infrastructure Project will Design, Augment/Rehabilitate/ Retrofit and/or construct new(a) water distribution network (to ensure 24X7 piped potable water supply);(b) Sewerage network; (c) Power distribution network; (d) Provision of Service Utilities (through underground Ducting, wherever feasible); (e) Designing and Re-laying of Roads (after completion of ducting work) and construction of Storm water drainage, and (f) SCADA system with the aim to provide contemporary urban facilities to the residents of the walled city area, to enhance their standard of living and “End User Satisfaction”.

4.0. Detailed Scope of Work and Technical Specifications

A detailed Section covering objective, Scope of Work (during construction & O&M), Technical Specifications, Final Acceptance & Testing, Performance Indicators (during construction & O&M), Resource requirements, Time schedule Sector specific conditions and Bill of Quantities for Water Supply, Sewerage, Power Supply, Multi-Utility Duct and Road & Drains has been provided in Section V.

5.0 Employer’s General Requirement

1. Background	1.1	Udaipur Smart City Limited (USCL) has been mandated to develop Integrated Infrastructure Project in Walled City (ABD Area) of Udaipur, as part of its Smart City Mission Program.
	1.2	The Integrated Infrastructure Projects is conceptualized with 24x7 water supply, complete sewerage network, undergrounding of utilities with multi-utility duct and smart road network across the ABD Area.
	1.3	Work will be executed through a Design–build–operate contract (DBO) contract where the contractor shall undertake the design and construction of the project, and undertake operation and maintenance for a period of 10 years including a Default Liability Period of 12 months.
	1.4	The executing agency is Udaipur Smart City Limited (USCL) and project management unit (PMU) is designed to function as the implementing agency for project administration and coordination and monitor all the project implementation activities of USCL. The project will support Public Health Engineering Department, Government of Rajasthan, Ajmer Vidyut Vitaran Nigam Limited and Public Works Department, Government of Rajasthan's efforts toward sustainable urban development in the city of Udaipur.
2. Project Location	2.1	Udaipur, also known as City Of Lakes or Lake City, is a major city and the administrative headquarters of the Udaipur district in the Indian state of Rajasthan. Udaipur is a very popular tourist destination, and known for its history, culture, scenic locations and the Rajput-era palaces. Udaipur is located at 24.525049°N 73.677116°E. The city covers an area of 37 sq. km. and lies at an altitude of 598.00 m (1,962 ft) above sea level. It is located in the southern region of Rajasthan, near the Gujarat border. The city lies 403 kilometres (250 mi) southwest of the state capital, Jaipur and 250 km (155 mi) northeast from Ahmedabad. Udaipur with its lakes lies on the south slope of the Aravalli Range in Rajasthan. The Northern part of the district consists generally of elevated plateaus, while the eastern part has vast stretches of fertile plains. The southern part is covered with rocks, Hills and dense Forest. There are two important passages in the Aravali ranges viz. Desuri Nal and Saoke which serves as a link between Udaipur and Jodhpur District.[12]
3. Climate Conditions	3.1	Udaipur city has particularly a tropical climate. The three main seasons, summer, monsoon and winter respectively, dominate the city of Udaipur. Being located in the desert lands of Rajasthan, the climate and weather of Udaipur is usually hot. The summer season runs from mid-March to June and touches temperature ranging from 23 °C (73 °F) to 44 °C (111 °F) in the months of March to June. Monsoons arrive in the month of July heralded by dust and thunder storms. With lush greenery and enchanting lakes, the sporadic rainfalls enhance the beauty of the city, making it one of the top monsoon destinations of the country. The winter season prevails from the month of October till the month of March. Humidity, which prevails during monsoons, diminishes at the arrival of winters. The city observes pleasant sunny days and enjoyable cool nights with the temperature ranging from 5 °C (41 °F) to 30 °C (86 °F). Udaipur's winter climate is the most appealing time to visit. Tourists arrive in large numbers, anytime between mid-September to late March or early April. Even in January, the coldest month, the days are bright, sunny and warm with maximum temperature around 28.3 °C (82.9 °F). Mornings, evenings and nights are cold.
4. Topography	4.1	
5. Communication	5.1	Udaipur is easily accessible by air, rail and road. Maha Rana Pratap International Airport in Udaipur City is a modern airport and most airlines

		have daily flights from all metros across India via Delhi and Jaipur. is touched upon by National Highway No. 8 connecting Delhi with Mumbai.
Particular Requirement of the Package		
6. Completeness of the Offer	1.1	The Bidder shall be fully responsible to include in his bid the whole of the Works, including each individual component, designed and constructed in accordance with technical specification defined herein. In absence, good engineering practice and best Industrial standards should be followed. The integrated project shall function as a whole citizen services, a system that is capable of achieving the 24x7 supply of potable water, assured power supply, sewerage connectivity and good quality roads. The Bidder within the tendered cost shall provide any accessories which are not specifically mentioned in the specifications/requirement, but which are usual or necessary for completion of the Works and successful performance of the plant and facilities. The Bidder shall, to the maximum extent practical and feasible, endeavor to offer standardized designs and Plant and equipment keeping in view minimization of operation and maintenance requirements. The Bidder shall ensure that his offered designs and equipment are "maintenance-friendly".
7. Facilities for the Client's Representatives	2.1	The Bidder shall provide upkeep, and maintain the following facilities during construction and execution work. The cost for these facilities shall be included in the Contract Price. a) Testing Laboratory at site office b) Testing Equipment at site
	2.2	Within 60 days, of award of work, contractor shall provide a site office Building including required office equipment i.e. fax, photocopy, internet/email, computer with colour laser printer of latest configuration / software (MS Projects, MS office, Primavera, AutoCAD). The location and layout of site office shall be got approved from the Engineer.
	2.3	Storage for the equipment to be installed under the subject contract will be provided by the Employer.
8. Construction Management	3.1	Site Organization
	3.2	Bidder shall describe the roles and responsibilities of each of the personnel proposed and shall describe the roles, relationships, and division of responsibilities between the site management and the representative head/branch office that will be responsible for the Project. In particular, the Bidder shall provide details of the technical and financial responsibility and authority of the Project Manager who will be responsible for the day-to-day operations at the Site.
	3.3	The Bidder shall provide a preliminary organization chart which indicates the relationship between the site management and the representative head/branch office, the direct on-site works operations, the sub-bidders and suppliers, and the Employer's Representative. Details shall be furnished separately for the design and construction phase, and for the operations and maintenance phase.
	3.4	Plant and Construction Equipment
	3.5	The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key plant and construction equipment. A separate Form shall be prepared for each item of plant and/or equipment listed, or for alternative equipment proposed by the Bidder.
	3.6	The overall requirements and mobilization/deployment schedule for each major item of plant and equipment (such as plant &equipment to be used, excavators, concrete batching plants, hot mix plants, etc.)
	3.7	Construction Schedule
	3.8	The Bidder shall submit his proposed construction program in sufficient detail so as to demonstrate: the order in which he proposes to carry out the Works (including each stage of design, procurement, manufacture, pre-

<table>
<tr><td></td><td></td><td>delivery inspection and testing, delivery to Site, construction, erection, testing and commissioning); all major events and activities in the production of Construction Documents; the periods for the design reviews and approvals and for any other submissions, approvals and consents specified in the Employer's Technical Requirements; the sequence of all tests specified in the Contract; etc.
The bidder shall also submit the micro planning program showing detail of area-wise and street wise execution of all activities in time bound manner. The construction program shall not be considered unless street wise plan has been prepared. Any street should not be left dug up for a period more than period proposed and approved by Authority. Any breach of this condition shall constitute a major violation of contract as convenience of citizens is the major reason for bundling all the components together.</td></tr>
<tr><td></td><td>3.9</td><td>The Bidder should pay particular attention to demonstrating how his proposed program for supply of major items of plant and equipment to be incorporated into the Permanent Works is to be managed to satisfy the requirements of the Contract, including the time required for design, placing of confirmed orders, manufacturing, pre-delivery inspections and tests, delivery to the Site, storage, installation, etc.</td></tr>
<tr><td></td><td>3.10</td><td>Such construction program shall be developed on a commercially available project management software (such as Primavera, MS Project or equivalent) showing level-3 activities, together with bar charts and CPM diagrams which clearly illustrate the critical path, and the resources required to be provided by the Bidder to achieve the desired results.</td></tr>
<tr><td></td><td>3.11</td><td>The Bidder's attention is drawn to the requirements set out in in this contract, and the Bidder is required to clearly demonstrate how he proposes to meet the Milestone Targets that have been established to ensure that pro-rata progress is maintained on all sub-components of the Works throughout the execution period.</td></tr>
<tr><td></td><td>3.12</td><td>Details shall be furnished separately for the design and construction phase, and for the operations and maintenance phase.</td></tr>
<tr><td></td><td>3.13</td><td>List of Manufacturers, Suppliers and Vendors</td></tr>
<tr><td></td><td>3.14</td><td>The Bidder shall provide details on the proposed manufacturers/ vendors/suppliers of major items of materials, plant and equipment that are to be incorporated into the Permanent Works.</td></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Sl. No</th><th>Description of Item (Material/Plant/ Equipment)</th><th>Name and Address of Manufacturer/Supplier/ Vendor</th><th>As per List of Preferred Makes/ Approved by SQCA</th></tr>
<tr><td>(A)</td><td colspan="3">Mechanical Work Components</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td>(B)</td><td colspan="3">Electrical Work Components</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td>(C)</td><td colspan="3">Instrumentation and Process Control</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td>(D)</td><td colspan="3">Civil, Building and Road Works</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
<tr><td></td><td></td><td></td><td>Yes/No</td></tr>
</table>
</td></tr>
</table>

					Yes/No
	3.15	Bidders QA & QC Plan			
	3.16	The Bidder shall provide his proposed Quality Assurance and Quality Control (QAQC) Plan which describes the type, frequency and procedure of tests to be done on sites; type, frequency and procedure of tests to be done at manufacturers' locations outside the sites; all parameters to be measured in these tests; permissible limits of such parameters; details of laboratories to be established at sites; details of testing equipment & machines and their calibration schedules; details of the Bidder's internal systems for assuring quality control at the manufacturers' outside the sites; details of qualifications and experience of the Quality Control professionals to be deployed for the entire project; and the systems of Quality Audit to be instituted for systematic and professional management as well as adherence with the highest standards of quality of all construction works.			
	3.17	The Bidder shall provide separate descriptions of its proposed QA/QC plan during the design and construction phase, and the subsequent operations and maintenance phase. The Bidder shall also provide copies of the company's standard rules and regulations regarding quality assurance and quality control procedures for works in general and works of a similar nature.			

6.0. Project Design & Approvals – Phase I

This contract involves Design, Build and Operational liabilities on the contractor. The Contractor will undertake Detailed Engineering Design for all the Six (6) components, which will be approved by the Engineer – In – Charge, during the Design Phase of Six (6) months. Only after the Approval of the Detailed Engineering Designs and Good For Construction drawings, to be prepared by the contractor and approved by the Engineer-In-Charge, within the Design Period, work will start

7.0. Final Acceptance Testing and Schedule of Guarantees

The Final Acceptance Testing shall be conducted as per process defined in detailed scope of work and all critical civil, mechanical, electrical equipment and SCADA Instrumentation are required to pass the test. Only after passing of Final Acceptance Test and with approval of EIC, the work will be deemed complete and Completion Certificate will be issued.

8.0. Operation & Maintenance

The Contractor will Operate and Maintain the facilities created for a duration of Ten (10) years, as per the KPIs defined below. The contractor will provide manpower and spare parts as deemed required at site for O&M of the facilities. The list of minimum manpower required attached with the bid is only indicative. Sector wise O&M details are indicated in subsequent sections (5 A, B, C. D. E and F) of this document.

9.0 Key Performance Indicators (KPIs)

This is to clarify that Penalty will be levied on the contractor only when the Procuring Entity has documented evidence that the "Non Compliance" of the KPIs of the O&M phase, as detailed in the Contract Agreement, is/are only due to an act of negligence, improper, un-professional methodology adopted for O&M of the system, by the contractor and/or absence of qualified and experienced manpower to be supplied by the contractor, at site.

9.1 Water Supply System

With a view to maintain a minimum level of service for proposed water treatment plant for Water-Energy conservation & economy of operations, various performance parameters need to be fixed.

9.2 Sewerage System

a. No leaks / blockages in pipes
b. No overflows from the Manholes
c. Frequency of cleaning of sewers with jetting machine
d. Frequency of submission of CCTV inspection report for the sewers
e. Execution of the entire work including finishing according to the drawings and specifications
f. Submission of “As built” drawings both in soft copies and hard copies (two prints and one polyester film)
g. Silt removed from the sewerage system should be removed by next day from the road side.
h. CCTV inspection to be carried out after removal of silt from the system and submitted to the Employer within a week.
i. The Contractor shall submit a weekly report to the Employer detailing the Operation and Maintenance indicating the labour hours expended and other Consumables consumed and also problems faced and rectified.
j. Minimum time for rectification
    - Blockage and overflows - 12hours
    - Stolen / Broken man hole covers - 12hours
    - Sewer spills from main sewer, branch and house service connections (between property chamber and public - 72hours
k. Record all complaints received regarding sewer blockage and clearance with same date and time.
l. Record condition of sewer found at the time of attending complaint. Damage notice should be recorded by attending staff
m. The Contractor shall carry out mandatory biannual cleaning of network before and after the monsoon season including cleaning of all manhole chambers and collection network irrespective of the regular maintenance work.
n. Identification and reporting of illegal connections on the sewerage network as soon as these are detected.

9.3 Electrical:

Key Performance Indicators (KPIs) for the electrical system in Udaipur Rajasthan include the following service quality, reliability, security, health and financial indicators.

1- System Interruption Frequency (**SIF**), will be measured on monthly basis. Number of interruptions experienced by any end user will not be more than 3 per month.

2- System Interruption Duration (**SID**), to be measured on monthly basis. Maximum duration of Interruptions experienced by any end user will not be more than 180 Minute per month.

3- Power losses Index (**PLI**), to be measured on monthly basis. Power Loss should not be more than 5%

4- Power factor **(PF)** to be measured on a daily basis, Power factor should not be less 0.98

9.4 SCADA System

The Contractor shall demonstrate its ability to reach the performance requirements. Performance tests shall be carried out during the Factory Acceptance Tests.

1. Computer Start Up

Total time for the start-up of a computer, including automatic program load, initialization and database updating, shall not exceed five minutes for critical functions (SCADA, front-ends servers). Automatic restart following a power outage shall also not exceed five minutes.

2. Complete SCADA functionality shall be available within a further five minutes following a start-up or automatic restart of the last computer in the minimum set of computers required to be running to

support this functionality. Updates from field devices may extend beyond this time but the full update of the System with data from the field shall not exceed a further five minutes. Thus, a complete restart of the System, including full update from the field, shall not exceed 15 minutes.

3. **SCADA System must have System availability of 99.9 %.**

Non Compliance with the Key Performance Indicators as mentioned above or any other additional indicator/s, as deemed essential for proper O&M of the system will attract a Penalty. An indicative list is included in SCC of this Document.

10. KEY PERSONNEL

Bidder shall provide minimum key experts for the integrated project as mentioned below during construction and O&M

Position	Minimum Experience Requirements	Number
CONSTRUCTION		
Project Manager	BE Civil, 15 years' experience in construction works and working at equivalent position.	1
Civil Engineer	BE Civil, 5 years' experience in construction works	3
Mechanical Engineer	BE Mechanical, 5 years' experience in installation of Pumps, valves, piping, etc.	1
Electrical Engineer	BE Electrical, 5 years' experience in Electrical systems for pumping stations.	2
QAQC engineer	Degree (Civil) with 10 years' experience in similar type of works. Degree (Civil) with 5 years' experience in similar type of works. Degree (Electrical) with 5 years' experience in similar type of works.	1 2 1
SCADA Expert	BE Instrumentation/ Electrical , 5 year experience in SCADA implementation	1
Safety Expert	professional having 10 years of experience in the similar nature	1
O&M		
Manager	BE Civil, 10 years' of O&M experience of infrastructure project	1
Supervisor	Diploma in Mechanical / Civil with 10 years of O&M experience of water supply system works Diploma in Civil with 10 years of O&M experience of sewerage system works Diploma in Electrical with 10 years of O&M experience of electric power distribution works	1 1 1

SCOPE OF WORK & SPECIFICATIONS

WATER SUPPLY

Chapter 1. System Description

1.1. Background

Providing basic services (e.g. water supply, sewerage, urban transport) to households and building amenities in cities which will improve the quality of life for all, especially the poor and the disadvantaged is a national priority.
Government of India has launched AMRUT Mission for providing infrastructural facilities related to Water Supply, Sewerage, Drainage, Transportation and Green Spaces.
Under this mission, 25 towns are identified in State of Rajasthan, which are as follows;

List of towns to be covered under the Project

S.No.	Name of Town	Name of the District
1.	Bhiwadi	Alwar
2.	Beawar	Ajmer
3.	Alwar	Alwar
4.	Gangapur City	SawaiMadhopur
5.	Bikaner	Bikaner
6.	Chittorgarh	Chittorgarh
7.	Baran	Baran
8.	Sujangarh	Churu
9.	Bhilwara	Bhilwara
10.	Nagaur	Nagaur
11.	Jaipur	Jaipur
12.	Jodhpur	City Jodhpur

S.No.	Name of Town	Name of the District
13.	Kota	Kota
14.	Bikaner	Bikaner
15.	Ajmer	Ajmer
16.	Udaipur	Udaipur
17.	Bikaner	Bikaner
18.	Sikar	Sikar
19.	Kishangarh	Ajmer
20.	Hanumangarh	Hanumangarh
21.	S. Madhopur	S. Madhopur
22.	Churu	Churu
23.	Hindon City (Karauli)	Karauli
24.	Jhalawar	Jhalawar
25.	Bundi	Bundi

Under these proposals, infrastructure for water supply is proposed to be provided/augmented to achieve equitable & potable water supply to each & every household in ABD Area Udaipur in State of Rajasthan.
The purpose of Atal Mission for Rejuvenation and Urban Transformation (AMRUT) is to

i. Ensure that every household has access to a tap with assured supply of water and a sewerage connection;

ii. Increase the amenity value of cities by developing greenery and well maintained open spaces (e.g. parks);

iii. Reduce pollution by switching to public transport or constructing facilities for non-motorized transport (e.g. walking and cycling).

1.2. **Sanction of the Project**

The reorganisation Urban Water Supply Scheme ABD Area Udaipurunder AMRUT Mission/SMART CITY Project is sanctioned in USCL Meeting dated27-01-2017.

1.3. **Project Objective**

The primary objective of the proposed project is to provide safe & potable drinking water to ABD Area of Udaipur City of UdaipurDistrict. The other secondary objectives are as follows:

- Creation of sustainable infrastructure for drinking water supply in project area.
- Improvement in health and reduction in instances of water borne diseases in targeted population.
- Reduction in hardships & improvement of quality of life especially for women & underprovided section of society.
- To ensure sustainability of investments through promotion of beneficiary leadership in decision making as well as ownership of assets created.

1.4. Project Location

The project is located in walled city of Udaipur city. The towns have independent source and water supply system.

1.4.1. LOCATION AND CONNECTIVITY

Udaipur District bounded on the northwest by the Aravalli Range, across which lie the districts of Sirohi and Pali. It is bounded on the north by Rajsamand District, on the east by Chittorgarh District, on the southeast by Banswara District, on the south by Dungarpur District, and on the southwest by the state of Gujarat. It is part of the Mewarregion of Rajasthan. It is located 403 kilometres southwest of the state capital, Jaipur, 248 km west of Kota and 250 km northeast from Ahmadabad. Udaipur is connected with Delhi, Jaipur and Jodhpur and other parts of India through road, rail, air network. Udaipur district is situated in the South of Rajasthan.

1.5. Present Scenario & Problem

1.5.1. Present Scenario & Problem

Presently water supply to the ABD Area, Udaipur is from ground water sources and surface water. Surface water is the source of clear water which receive from Pichhola Lake. Raw water from Pichhola Lake is pumped to existing WTPs via RWPS at Dudh Talai. There are total capacity of water treatment plants for ABD area is 30.73 MLD from Dudh Talai WTPs (2 nos. of capacity 13.5 MLD and 2.85 MLD), Gulab Bagh WTPs (2 nos. of capacity 4.54 MLD and 2.27 MLD), Patel Circle WTP (1 no. of capacity 7.57 MLD), Fatehsagar WTP (2 nos. of capacity 3.4 MLD and 1.72 MLD) out of which Patel circle and Gulab bagh WTP supply partially to ABD Area.

In the existing system there are 3 Nos CWRs. 2 Nos of OHSR heaving total Capacity 850 KL.

Total length of distribution pipe line is approximate 99 k.m.

The total no. of service connections are 15,576 which includes 14814 total domestic connection.14814 domestic metered connection, 682 non-domestic metered connection and 80 industrial metered connection.

1.6. **Design Concept**

Design period for the project is taken as 30 year and considering 24 month execution period, population & demand forecast has been done for year 2051. However, in the present proposals, different components of the project are designed as per approved design parameters of the department. Civil works like cross drainage works, land acquisition, forest clearance, right of way permission etc. are designed for ultimate demand of year 2051. Project components designed for 15 year are designed for year 2036 demand and that of for 30 years are designed for year 2051 demand. Following design parameters are adopted for designing the project:

✓ Civil work for Raw Water Pumping Station	✓ For installation of Pumping Machinery for the demand of 2051
✓ Civil work for Clear Water Pumping Station	✓ : For installation of Pumping Machinery for the demand of 2051
✓ Pumping Machinery	✓ : For the demand of 2051
✓ Raw Water Rising mains	✓ : DI pipe line for the design demand of year 2051.
✓ Clear Water Rising mains	✓ : DI pipe line for the design demand of year 2051.
✓ Water Treatment Plant	✓ Water Treatment Plant for the raw water treatment capacity equal to daily demand of 2051.
✓ Service reservoirs	✓ : Service reservoirs for the storage capacity equal to one third of daily demand of 2051.
✓ Distribution net work	✓ : DI Pipes for the demand of year 2051.
✓ Ancillary Civil works	✓ : For year 2051

1.7. **Per capita Water Requirement**

As per recommendations of D&S PHED Guidelines for rate of water supply in urban towns the designed demand of drinking water is calculated @ 135 LPCD. A consideration of 15% of system losses is also adopted above this LPCD.

1.8. **Main Component of Project**

Detail proposals are explained in forthcoming Chapters, however project components for ABD Area of Udaipur City are summarized as under:

- ✓ Providing, Laying & jointing of 1665Mtr- 250-600 mm DI K-7 Water Pumping Main and 600 M for inter connect 250mm D.I. K-7, 110 M for inter connect 300mm D.I. K-7.
- ✓ Construction of 23.47 clear water capacity Water Treatment Plant at Machla Magra.
- ✓ Construction of 1 Nos of Service Reservoirs with Capacity Range 5100kL and 1 Nos Clear Water Sump of capacity range 240 KL at Machla Magra.
- ✓ Rehabilitation of existing raw water pump house at Dudh Talai at various head works.
- ✓ Providing, Laying & jointing of 100 mm to 600 mm DI K-7 Distrbution pipeline for 88210 m.
- ✓ Providing & installation of Consumer meters & House Service Connections of different sizes – 19025nos.
- ✓ Installation of pumping machinery at Dudh Talai RWPS.
- ✓ Construction of Master Control Center & Consumer Care Center.
- ✓ Installation of PLC/ SCADA & communication system.
- ✓ Provision for 11./0.43 kv GSS and dedicated power feeder etc.
- ✓ Supply of spare parts and tools & tackles
- ✓ Operation & Maintenance of the project for 10 years including one year defect liability period.

Chief executive Officer

Udaipur Smart City Limited

Chapter 2. Scope of Work

2.1. General Principles

The contractor shall carryout all works of towns wholly in accordance with the terms and conditions of the contract to fulfill the requirement of the individual project. All the material used, and the equipment installed shall be as per the specifications defined in the contract and the work shall be executed with good engineering practices.

Generally the following activities shall be carried out for each component of this contract but shall not be limited to:

I. PREPARATION & SUBMISSION OF SERVICE IMPROVEMENT PLAN (SIP) BASED ON REQUIRED SURVEY; INVESTIGATIONS AND DESIGNS: For completion of the job in the prescribed time, it is essential to maintain a timely execution schedule linking with physical progress with financial progress as per action plan and logical sequencing of the contract activities. In view of the above the contractor shall submit a SIP based on Critical Path Method for approval of department.

II. While designing of the various components of proposed project, due care has been given to make maximum possible utilization of the already created assests like pipeline, CWPH, Reservoirs, Valves etc. in the town. If during execution of project it is found that any other existing component can be useful for this project, the same shall be utilized for this project, as per direction of EIC.

III. Conduct topographic survey of the project area and preparation of Map(s) to show the levels, road width, existing services, obstacles, etc.

IV. Surveys for all underground utilities and above ground utilities and marking on GIS based maps by linking with geo referenced points of ABD Area.

V. Mark all registered consumer connections on the map on GIS platform.

VI. Review the technical sanction of the project provided by PHED including all designs and provisions for distribution system and DMA assignments.

VII. Prepare and get approval of designs of hydraulic modelling design of 24x7 ABD area water supply, architecture of PLC and SCADA and automation.

VIII. Submission of all documents required according to the Contract (security money / guarantee, etc.)

IX. Submission of Action Plan/Construction Schedule in accordance with the provisions of Special Conditions Part A for approval of the Engineer in Charge. The contractor should submit construction schedule for ABD area Udaipur.

X. Conducting required investigations to confirm that the provisions of system proposed are sufficient to fulfill the required objectives of the work. For this the contractor shall verify the ground levels given by the department and shall carry out the required survey & designs to satisfy with the design provisions given by the department. If the provisions envisaged by the department are considered to be inadequate, the Contractor shall provide additional facilities / systems so that the objective of delivery of designed demand is achieved. No additional payment on account of providing such additional facilities / systems shall be made.

XI. Carrying out necessary Topographical survey for the water mains, head works, and campus development within the limits of the contract in consultation with the Engineer in Charge. During survey the contractor shall check the alignment of existing services along proposed water mains The survey shall be got done using Total Station.

XII. Preparation and submission of the L-sections, layout plans and conceptual drawings, structural drawings etc. and all other drawings and details for planning of all components of the project. The drawings must be on scales as per the prior approval of the Engineer in Charge. Plan should show alignment of pipeline, required road cut portion and type of pavement. The contractor will prepare the case for obtaining of permission for Road Cut from the concerned agency.

XIII. Conceptual drawings of GLSR, anchor block, thrust block, valve chambers, pump house, CWR etc. are given in the tender document. The contractor is required to submit the detailed structural designs and execution drawings (wherever required) all civil, mechanical and electrical engineering works. He will also submit the detailed system and working drawings as well as performance curves and data for all hydraulic, mechanical, electro-mechanical and electrical equipment. In drawing of SVC/AVC, reinforcement may be changed as per design & present practice.

XIV. Conducting required soil/ strata investigations for the foundation of Intake/RGF/ CWR's/PH/pipeline and other civil works in all type of soil condition. The soil characteristics (bearing capacity, chemical analysis,) are to be determined. It is also important to assess the possibility of erosion and the stability of the soil with a view to the lateral resistance to be taken into account and to the exposure of foundations. The soil resistively and chemical analysis will be got done at all pumping stations to determine the soil characteristic. The contractor shall do all lab/field tests for the determination of optimum moisture content for soils from different borrow pits to achieve required density of embankment. Additionally he has to assess the type of soil, the strata, the level of ground water and other indicators if any and establish soil profiles and submit these to the Engineer in Charge. Special attention is required to determine the corrosive nature of soils where the Conducting required soil/strata investigations for the foundation of structures are to be laid. The contractor shall also carry out required investigations for rock strata on which foundations are to be laid and for other civil works.

XV. Based on the SBC at construction site, preparation and submission of the structural drawings of WTP, CWR, pump house, GLSRs, residential buildings & other structures for which execution drawings are not provided in the tender document (Vol-III) etc. and all other drawings and details for planning of all components of the project. The drawings must be on scales as per the prior approval of the Engineer in Charge.

XVI. Submission of the hydraulic calculations for the design of the pumping stations, pipeline and treatment plant.

XVII. As the responsibility to supply the designed demand to the various hydraulic zones and District Metering Areas is solely of the Contractor, the Contractor is required to review the design of the pipe network, the pumps, the surge analysis etc. and the instrumentation system on his own and if required shall use the appropriate duty conditions of the pumps, use additional materials/equipment(s) so as to achieve the objectives of the work as defined in clause 2.1 above. In case it is felt necessary to provide surge protection system, cost of the same should be included in the lump sum offer.

XVIII. Approval of required design and drawings, material to be used, equipment specifications and the samples, prior to commencing of work on site. Unless mentioned otherwise, if for any specific provision / references have been made in more than one specifications, the provision which are more stringent shall be applicable.

XIX. Preparation and submission of required detailed working drawings on the basis of conceptual drawing and plans given by the department. Detailed electrical drawing of pumping station, electrical & sanitary drawings for residential buildings shall also be submitted by the contractor.

XX. The water tightness test of water retaining structure like CWR, GLSR, Floculator etc shall be done prior to inside & out side painting on the structure. Inside & out side paint of the structure shall be applied only after successful completion of water tightness test.

XXI. Providing adequately planned plinth protection works for all new buildings & reservoirs to be constructed.

XXII. To co-ordinate with the O&M staff and concerned PHED officers, electrical supply company and personnel of water supply system for carrying out the installation of new equipments.

XXIII. All the dismantling joints to be installed in Intake, WTP & pump houses shall be bellows type dismantling joint and the dismantling joints to be provided at other places like CWR, SR, pipe line may be telescopic type CI dismantling joint. telescopic type CI dismantling joint should be of one of the approved vendor.

XXIV. Manufacturing, shop testing, pre-dispatch inspection, transportation to site, providing transit insurance, storage, handling at site, installation, sectional testing, pre-commissioning testing, commissioning and trial runs for all components of the system including the hydraulic, mechanical, electrical, electro-mechanical and

instrumentation equipment & automation system. Before selection of any electric or instrumentation equipment check compatibility with requirement of PLC/SCADA system.

XXV. Pressure rating of all the fittings/ valves/ specials installed at particular location shall be in accordance to working pressure plus surge pressure at that particular location subject to minimum rating as PN-1.6 for Intake/ PH/ CWPH/ IPS and minimum PN-1.0 for WTP & Pipe line. If any contravorsy is found in pressure rating between this clause & forthcoming chapters, provisions of this clause shall be applicable.

XXVI. Resilient seated sluice valves, butterfly valves, kinetic air valves & non return valves etc valves shall be used at following locations of water supply schemes/projects:-

1. Pumping Station(s)
2. Treatment Plant(s)
3. Supply Control Valve near OHSR/GLSR.
4. Valves of distribution system which are operated regularly for zonal supplies, and
5. Valves of all main transmission system(s) of scheme/ project

XXVII. Submission of 'As Built' drawings and Operation and Maintenance Manuals.

XXVIII. Providing spares, tools and tackles for all components of the project.

XXIX. For road crossings, the department shall apply and deposit the estimated cost demanded by the respective departments. For open cut road crossings the work of restoration of road shall be limited to the re-grading and construction of road up to sub-base layer. Highway crossings shall be done with trenchless technology as per drawing / design given by concern department.

XXX. For laying pipeline the cost of shifting of electrical poles, transformers etc. shall be borne by the department. The bidder shall be responsible for any damage occurred to the telephone lines, distribution/ rising main water and gas pipes, drains while laying raw water pipeline, and shall be liable to pay the amount levied by respective department(s) for the repair and/ or damages so occurred.

XXXI. For Railway track crossings, the department shall apply and deposit the supervision charges demanded by the Railway departments. Contractor shall be fully responsible to contact concern Railway department officials for taking permission to conduct railway track crossing by push technique (Horizontal drilling, without open excavation) as per drawing / design given by Railway department. Providing, Fixing, installation & commissioning of all material (like MS casing pipe of double size of carrier pipeline, MS carrier pipeline, fixtures, Sluice Valves on both ends with chambers etc.) shall be done by contractor under this package.

XXXII. Marking of completed assets on GIS Platform - The contractor shall submit geo-referenced AUTOCAD drawings for the complete pipeline network laid under the contract. Location of all valves and Tees, bends, junctions and joints of change in alignment of pipeline shall be determined using differential GPS of 0.6 m accuracy or better. Attributes of pipeline, like diameter, material, class etc shall

be linked with GIS. The contractor shall be responsible for getting the alignment of pipeline and other infrastructure created under this project marked on the GIS platform of department.

XXXIII. Operation, routine & preventive maintenance, maintenance and repairs of the complete system during one year defect liability and thereafter for a period of 9 years O&M period, starting from the date as defined in Volume I of tender document, in Special Conditions of contract. The O&M should be done , including preventive maintainance, as per provisions of Manual issued by CPHEEO.

XXXIV. Providing spares, tools and tackles at the end of the execution of physical works as per list enclosed.

XXXV. Contractor shall monitor, check & report the meter reading of all bulk water meter installed in the system to ensure that the system is smoothly & efficiently maintained to the satisfaction of department & users. This activity is the soul of this contract and therefore contractor shall execute the project with good skill & engineering practice. The daily reading of these meters should be accessible to all concerned departmental persons from anywhere at any time during entire O&M Period. The contractor should make all arrangements to keep the NRW in each individual DMA within acceptable limit.

XXXVI. Contractor shall co-ordiante with different concerned departments in getting various statutory permissions required for the project. Latest status of Various hindrances (and all its relevant documents), which may result in delayed completion of the project, should be accessible to all the concerned persons of the department from any where at any time.

XXXVII. To perform the required tests to fulfill the requirement of applicable codes.

XXXVIII. In addition to the above, the following shall also form a part of the scope of work:

a. Providing one air conditioned closed vehicle to department with POL and driver during entire period of the execution and O&M for supervision of the work. The vehicle should not be more than three years old.
b. Providing, installation and maintenance of 5 nos. of split case type air conditioners, 1.5 tonne capacity of Voltas/ carrier/ blue star make for Additional Chief Office, Superintending Office and 3 nos for Executive engineer office (City Div. I, II and District division).
c. Arrangement of adequate security, watch and ward of the system during the execution period to safeguard the equipment and completed section of the work from any type of mishandling, theft, fire and other hazards, etc. shall be made in addition to the above requirements.
d. For completion of the job in the prescribed time it is essential to maintain a timely construction schedule linking with physical progress with financial progress as per Annexure "B" enclosed and logical

sequencing of the contract activities. In view of the above the contractor shall submit a construction schedule based on Critical Path Method for approval of department.

e. The work will be executed based on SIP submitted by the bidder and as approved.

f. To adhere to the execution schedule approved by the department, the contractor shall also deploy the required technical expert having adequate experience of managing and monitoring SIP activities as directed by Engineer in Charge. The progress of these activities of the SIP should be accessible to all the concerned persons of the department from anywhere at any time.

g. All components of works shall ensure a logical sequence of execution, construction, supply, installation, testing, and commissioning. This progress should be accessible by all the concerned persons of the department from any where at any time. If any supply / construction of a material / unit is made, not in conformity to the logical sequencing of the work component, no payments will be entitled against such supplies, construction and installations. There has to be a continuous chain of work to ensure that pipes / material supplied by the contractor are laid / installed promptly and those laid / installed are sectionally tested in the field without any delay. If however, the progress of the work is hampered unavoidably, due to reasons beyond the control of the contractor, payment against supply shall be admissible against submission of appropriate Bank Guarantee of any scheduled bank. However such circumstances for not testing the pipes / reservoir shall be subjected to verification of the reasons, in the progress of the work, not being attributable to the contractor by an officer not below the rank of Superintending Engineer of the circle under whom the jurisdiction is vested. Latest status of Various hindrances (and all its relevant documents), which may result in delayed completion of the project, should be accessible to all the concerned persons of the department from any where at any time.

h. It will be the responsibility of contractor to maintain simultaneous pro-rata progress of works

i. For all Campus areas and constructed buildings under the contract, the contractor shall provide facilities of potable water and proper sanitation without any additional charges.

j. Maintaining the site office(s) with all reasonable office.

k. Restoration of PHED's premises / internal roads etc. after completion of the work shall also be a part of the work.

l. Where ever it is mentioned that the data/ information/ status of activity/ details of activity or any required information in approved

manner/format etc. should be accessible to all the concerned persons of the department from anywhere at any time the contractor will use online collaboration tool for the same. The tool should have required features and compatibility and contractor will arrange & provide necessary permission for giving access to departmental persons

m. Contractor shall provide sign boards at every work site stating the project detail. Matter to be written on the board shall be finalized by EiC. The board should be made of minimum 3mm thick MS sheet with 35x35x5mm Angle Iron Frame & support, dully painted as per direction of EiC. Display board (min size 3 feet X 4 feets) shall be installed at each IPS, GLSR, WTP, CWPH etc. Major Components of Work

XXXIX. The contractor shall submit total 20 nos. samples of model of water meters from all size offered before procurement. Out of these meters any 5 samples shall be selected randomly and the department shall send the same duly sealed to FCRI Palghat for Type Test including Life Cycle Test (as per IS 779-1994, clause 12.4). Remaining 15 no's will be returned to bidder. The cost of these tests along with incidental charges will be borne by the Contractor. The acceptance of meters will depend on conformity to the required provisions.

a. If the manufacturer has the required certificate issued by FCRI Palghat after 31.03.2015 same will be accepted and no fresh test will be required to be conducted.

Note: All the works narrated above shall be got executed as per relevant IS code and guidelines of CPHEEO manual of water supply and treatment, amended up to date.

The details of these components are as under:

2.2. Main Components of Work to be taken up under the Contract

The works under this contract are broadly divided under the following components:

i. For establishing 24x7 water supply system in selected area of walled city for Area Based Development (ABD).
ii. Instrumentation, Automation in Pump Houses, Water Treatment Plant, Rising mains and Distribution network.

Detailed proposals are explained in forthcoming Chapters, however project components for Udaipur are summarized as under:

ABD Area:

The components of works required for establishment of 24x7 water supply system in the ABD area, shall be as follows:

At Dudh Talai Raw Water Pumping Station

i. Dismatling of worn out/ inefficient pumping machinery including their suction and delivery arrangement dedicated to 3 WTPs.
ii. Extension of existing Dudh Talai RWPS by constrcting fabricated cantilevered steel structure for suspending raw water pumps in Pichhola Lake.
iii. Rehabilitation/ modification of Dudh Talai RWPS and Dudh Talai JEN Office as per approved Architectural design by EIC.
iv. Installation of raw water pumps for pumping raw water to Existing Patel Circle and Dudh Talai WTP and new Machla Magra WTP to be constructed under this contract.
v. Installation of Local SCADA hardware and software to poll data from instrumentation and automation to be done at Dudh Talai RWPSs and its integration with installed PLC/SCADA for communication of data to Master Control Center.
vi. Operation & Maintenance of all the civil, electromechanical and instrumentation works being done under this contract for 10 years including one year defect liability period.

Machla Magra Campus

i. Construction of 23.47 MLD clear water capacity Water Treatment plant along with all its units, repair and extension of existing approach road.
ii. Installation of pumps for clear water pumping station on clear water sump of capacity 240 Kl being constructed under this contract.
iii. Construction of 5100 Kl GLSR and its interconnection with existing High Zone GLSR.
iv. Complete SCADA, instrumentation, automation and Electro-mechanical works of Water Treatment Plant and CWPS.
v. Operation & Maintenance of all the civil, electromechanical and instrumentation works being done under this contract for 10 years including one year defect liability period.

Rising Mains Network

i. Exisitng 600 mm dia MS raw water rising for Patel Circle is to be disconnected at chainage 1350 m (JN-01) from Dudh Talai RWPS and connected to new 600 mm Di K-7 rising main being laid under this contract up to Cascade aerator of Machla Magra WTP being constructed under thic contract.
ii. A new 450 mm DI K-7 rising main from Dudh Talai RWPS to JN-01 is to be laid and interconnected to existing 600 mm Dia MS pipeline for feeding raw water to Patel circle WTP.
iii. Providing surge protection system as per design in rising mains to Dudh Talai WTP, Patel Circle WTP, Machla Magra WTP from Dudh Talai RWPS.
iv. Operation & Maintenance of pipelines being laid under this project and surge protection system for 10 years including one year defect liability period.

Improvements in Distribution System of ABD area

i. Providing, Laying & jointing of 88210 Mtr- 100-300 mm DI K-7 distribution pipeline and interconnection with existing DI pipelines in ABD area and dismantling of existing AC/CI/MS/GI pipelines for 24x7 water supply in ABD area.

ii. Replacement of all consumer water meters, Providing new Consumer meters and new house service connection to the 19025 nos. connections of ABD Area.

iii. Converting Distribution system in DMA pattern.

iv. For automation and remotely control of water supply in ABDarea; providing Instruments at DMA centres (Flow meter, Pressure Sensor-Transmitters) at pressure reducing valves at required points of each DMA for uniform flow due to the undulations in ground levels in ABD Area Udaipur.

v. Providing RTU/ PLC panels with required nos. of I/Os for communication and control on DMA and supply operations.

vi. Operation & Maintenance of 24x7 supply system for 10 years including one year defect liability period.

Master Control Center

Contruction of master control center at specified location by USCL.

Consumer Care Center

Construction of consumer care center in ABD Area.

2.3. SIP PREPARATION:

The preparation of Service Improvement plan for this project shall take

2.3.1. Deliverable Documents for SIP

i. Designs should be prepared including sectional completion of requirements.

ii. Detailed design & drawings and Suggestion of changes, if any, required for improvement.

iii. Work plan, methodology and timelines for implementation should be in line with the USCL's intentions;

iv. Detailing of Integrated Contract Management System by using latest software like Primavera, MS project, data capture, management and reporting structures, protocols;

v. Contractor Personnel Deployment Plan;

vi. Construction Plan and deployment plan;

vii. Cash-flow for the entire contract with sectional completion breakup;

viii. Detailed methodology for continuous monitoring of the performance of the Contractor in achieving and maintaining the Performance Standards for release of the eligible Operating Payments;

ix. Compliance matrix of contract and service requirement, O and M requirements and other requirements like social, environmental, resettling etc.

Operating and Management related Deliverable:

i. Annual Operating Plan (AOP) covering all operations, maintenance and management requirements in the Service Area;

ii. A system efficiency report of fortnight basis for assessment of NRW in each DMA and half yearly basis for assessment of Sub district NRW based on step test for each DMA. Every system efficiency report shall include efficiency of all zones and step test results for tests performed during the period of reporting.

iii. Public Relations Plan;

iv. Standard Operating Procedures (SOPs) for routine operations and emergency responses;

v. Water Quality Monitoring Programs;

vi. Energy optimization program;

vii. Detailed procedure for taking measurement and calculation for assessment of amount of bonus payable/ compensation to be recovered from O&M monthly bills towards energy efficiency in operation of raw water pumps and operation of WTP and clear water pumps.

viii. Periodic reporting plan including the formats for different performance reports;

ix. The computer hardware and software improvement plan for continued operation of the MIS, instrumentation and SCADA.

2.3.2. Preparation of Service Improvement Plan (SIP) Document:

Contractor during preparation of SIP will be allowed for refinement of overall design of the network for reduction of DMAs/ Zones for long term efficiency, effectiveness and sustainability by PHED.

Contractor, in his SIP as a part of "Value Engineering" (Value Engineering shall be in such a way that cost estimates of work does not exceed the corresponding physical quantity

of the work), may include proposal which in the Contractor's opinion will reduce the cost of constructing, maintaining or operating the Works, or improve the efficiency or value to the PHED of the completed Works, or otherwise be of benefit to the Employer. Any such proposal may be considered by the Engineer with due diligence looking to the bid sanctity.

The SIP comprises of the following two parts:

Part I – Design Built Works:

i. SIP should be prepared based on PHED's requirement including sectional completion requirement.

ii. Detailed design, drawings and cost estimates of work and improvement as a part of Value Engineering should be proposed to meet the Performance Standards.

iii. Work plan, Methodology and timelines for implementation should be in line with the USCLs' broad concept /requirement.

iv. Detailing of integrated Contract Management Information System by using latest software like Primavera, Microsoft office architecture, data capture, management and reporting structures, protocols including all related hardware, software, installation;

v. Contractor Personnel deployment plan;

vi. Construction Plant and equipment deployment plan;

vii. Cash-flow for both the construction of the O&M part.

viii. Asset Replacement Schedule with justification;

ix. Detailed methodology for continuous monitoring of the performance of the Contractor in achieving and maintaining the Performance Standards for release of the eligible Operating Payments;

x. Compliance matrix of contract and service requirement, O&M requirement and other requirement like social, environmental etc.

Part II –Operating and Management Procedures and Policies:

i. Annual Operating Plan (AOP) covering all operations, maintenance and management requirements in the Service Area;

ii. Emergency Response Plan (ERP);

iii. Consumer Management and Public Relations Plan;

iv. Standard Operating Procedures (SOPs) for routine operations and emergency responses;

v. Water Quality Surveillance Program;

vi. Energy optimization program;

vii. Periodic reporting plan including the formats for different performance reports.

Contactor shall submit the outcome of each activity for review of USCL/PHED's representative immediately after completion of the activity. USCL/PHED's representative will review the outcomes on regular basis and will submit their review comments within 15 days of receipt of the document. Contractor shall also submit the activity wise monthly report for monitoring of the USCL /PHED. Progress of all activities will be reviewed on monthly basis.

2.4. **Commissioning of DMAs**

The scope of work under conversion the existing distribution system to DMA pattern shall consist of the following requirements;

2.4.1. **Methodology of Services**

Distribution Network Improvement (DNI) on DMA basis :
The Distribution Network Improvement (DNI) shall be based on DMA basis. The Contractor shall, set up hydraulically isolated District Metered Areas (DMAs) within the Service Area of ABD area. Each DMA comprising of about 500 to 1000 consumer connections shall be considered as basic administrative unit for the purpose of sectional commissioning and O & M purpose. The Contractor shall design water supply distribution network on DMA basis to ensure equitable, continuous, pressurized water supply to the Consumers by using the hydraulic model and simulating both present (2017) and future (Year 2051) conditions. Each DMA, preferably, have one inflow point and be isolated by installing valves / end plugs. DMA at entry point will be provided with a bulk flow meter. Each DMA will have at least two Critical Measurement Points (CMPs) for continuous logging of pressure, one of the CMPs shall be at the entry point near bulk water meters and the second one shall be at the farthest/ highest point from the DMA entry point. A pressure reducing valve shall also be provided in each DMA for uniform pressure distribution in DMAdue to large undulations in ground levels and achieving minimum 17 m terminal pressure at consumer end. The performance parameters of the contractor including O&M period shall be assessed on DMA basis. The O&M agency (PHED/USCL/UMC) will also organize themselves in the same manner over the contract period. DMA wise fortnight reports will be generated to assess the DMA performance. fortnight meter readings will be taken and will be linked to the NRW assessment system.

2.4.2. **Methodology for designing of DNI**

Most of the existing distribution system will not be used in the proposed Distribution Network Improvement (DNI) plan, as the majority length of the entire existing distribution network will be replaced with new one under this contract. Scope of contractor will

involve both technical and consumer orientation with social approach. The consumers shall be taken in confidence and be informed time to time for the status update. Disconnections of old connections and old pipelines is very critical. Contractor will disconnect old connections and pipelines on commissioning of new pipelines. It will be verified by EIC's representative before making payment in DMA. All the connections shifted from old to new system and new connections given shall be recorded on GIS based database, being developed by third party authorized by the Department, duly attaching each connection with meter serial number to respective property with social and contact data of each consumer available in database. This database shall be of use to understand demand of water and also for servicing consumers. The physical work shall not be started in more than 3 DMAs at a time and unless the work is completed including commissioning of the new system and complete decommissioning of the old system in one DMA, no fourth DMA shall be taken in hand.

- Works shall be planned and executed to provide continuous pressurized water supply in each DMA. The Zones/DMAs shall be equipped with the instrumentation for monitoring the performance of service delivery in the area. The instrumentation capable of transferring the real time data to the SCADA system shall include the parameters of performance evaluation of the contractor during the operation, maintenance and service delivery. It shall include the DMA inlet flow meter, DMA outlet flow meter if any (if the outlet of one DMA forms the inlet for other), the pressure sensors/transmitters at critical measurement points. A pressure reducing valve shall also be provided in each DMA for uniform pressure distribution in DMA due to large undulations in ground levels and achieving minimum 17 m terminal pressure at consumer end. The consumer meter reading data for a given month of all the consumers within DMA shall be collected and entered in the billing system by third party PHED personnel monthy/bimonthly and shall be used in conjunction with the Zone/DMA inlet and outlet meter data for the fortnight to work out the NRW of the Zone/DMA/complete system. The pressure readings transmitted by the pressure sensors/transmitters at critical points in DMA shall not only be used for the performance monitoring and payment mechanism but also for continuously improving the model, interpreting the possible leakages in the DMA using the bulk flow meter and consumer meter data and running the model to understand the implication of the pressure readings.

- The Contractor's approach and methodology towards this work shall be in line with the overall principles and thinking of the Employer stated above. The SIP for DNI shall be compatible with these concepts.

2.4.3. **Methodology for measurement of NRW and real losses during operation services**

The contractor's methodology shall also spell out how the NRW and real losses will be measured within his battery limit which starts at offtake point on Dudh Talai RWPS to

Machla Magra WTP and ends at the consumers in 31 DMAs in ABD area. The PHED's Concept for this is described below and the contractor's methodology shall be generally in tune with it with further better modification.

The International Water Association (IWA) matrix method for the assessment of water loss at different stages shall be followed. A typical IWA water balance matrix is given below:

<table>
<tr><td rowspan="4">Own Sources</td><td rowspan="9">Corrected system input Volume</td><td>Water Export</td><td rowspan="4">Authorized Consumption</td><td rowspan="3">Billed Authorized Consumption</td><td>Billed Water Exported</td><td rowspan="3">Revenue Water</td></tr>
<tr><td rowspan="8">Water Supply</td><td>Billed Metered Consumption</td></tr>
<tr><td>Billed Un-metered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water (NRW)</td></tr>
<tr><td rowspan="5">Water Imported</td><td rowspan="5">Water Losses</td><td>Unbilled Un-metered Consumption</td></tr>
<tr><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies and Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage Transmission and/or Distribution mains</td></tr>
<tr><td>Leakage overflow at Utility Tank storage</td></tr>
<tr><td>Leakage on Service Connections upto point of Consumer metering</td></tr>
</table>

Figure 1: IWA water Balance Matrix

- The application of this matrix for the performance based operation payment will be with control point for input measurement at flow meters installed at;
  i. Common delivery of pumps at Dudh Talai RWPS.
  ii. Intanke of raw water at WTP Machla Magra.
  iii. DMA Inlet points

  And the sum of the consumption based on the sum of meter readings of the consumers which are billed or unbilled and the flow recorded by the bulk water meter on the pipeline. During initial take over period, NRW will be calculated from water supplied

from and measured at offtake points and the consumer consumption based on the sum of meter readings of the consumers.

The contractor is also to give accounting of DMA on fortnight basis and provide NRW assessment report of each DMA on fortnight basis.

iv. For stage wise application water balance between following has to be analyzed:

- Inlet points for ABD service area & consumers in ABD service area.
- Each DMA Inlet and consumer meters under it.

The monitoring is to be started as soon as DMA is commissioned and the contractor will submit details in key parameters (pressure, bulk supply, consumer readings zone/ DMA wise etc). The complete water supply system will be controlled and operated on SCADA. The bulk supply of water at each stage i.e. CWR, GLSR, Zone & DMA will be accessed through SCADA on specifically designed software. Bulk flow meter reading should registered every day at fixed time (generally before start of supply in morning). It should be accomplished through SCADA report generation. Domestic water meter reading at stipulated time in stipulated periodicity (the periodicity can be kept weekly or as felt fit by the Engineer).

2.4.4. Methodology for commissioning of zone cum DMA

The contractor shall give a complete methodology for commissioning of DMAs which shall include an exhaustive and sequential method with the formats designed to achieve and monitor:

- The distribution system pipelines in a DMA/ zone hydraulically tested.
- Readiness of database of all the properties and consumer registered / unregistered to be connected to the new system on GIS based map of the DMA with clear indication of roads.
- Proposal to connect all the consumers to the new system and methodology for pressure and flow control of each consumer vis-à-vis his registered demand.
- A vigilant surveillance to see that no reverse flow occur, no high consumptions go un noticed shall be done for first some months. The pattern of water flowing out of GLSR be critically observed for the entire day at 10 minutes interval for initial months. Unusual night flows shall be checked by surveillance visits in the night at the time when unusual high flow is seen on bulk outlet meter.

2.5. Pipe Line Work

The scope under the item shall consist of the following requirements;

(i) Manufacturing and Testing at works, transportation, packing, supply of all sizes of DI-K7 pipes, specials, jointing material etc to be used. Stacking and/or storage of material, rehandling and to lay pipes below ground by excavation and refilling the trench to ensure minimum cover of 0.9 meters generally and construction of

pedestals/portals for pipe support to lay pipe above ground, if required, and then to carry out sectional testing, precommissioning checks, full completion tests and trial runs. The water required for sectional testing after laying of pipe shall be arranged by the contractor at his own cost.

(ii) Submission of L-section and plan for approval of Engineer-in-Charge prior to commence the work and after approval take up the work and submit As-built drawings after laying and testing of pipeline.

(iii) Setting out of works, Laying and jointing of pipeline including lowering, placing at proper alignment, cutting pipes, chamfering complete in all respects. The work of laying and jointing of pipes and pipe appurtenances should be done at required levels. The pipeline alignment in general shall be kept on the outer edge of the existing/ proposed road boundaries. Wherever this is not possible, on approval of Engineer-In-Charge, the pipe can be laid near the road or within the carriageway. No extra payment shall be made on account of additional excavation required for placing pipes further away from the road centres. No additional payment shall be made for excavation of road surface or any other strata for the approved pipe alignment. The alignment approved by the Engineer-In-Charge shall be final and binding on the contractor.

(iv) Cutting of the vegetation for the purpose of excavation. However, it will be contractor's responsibility to obtain all kind of clearances, if required, to cut the vegetation for laying of pipe line and other civil works, if the forest department will raise the amount against the cutting of the said vegetation, the amount will be deposited by the department, but the contractor shall have to hand over the wood of damaged vegetation to forest authorities as per directions at his cost.

(v) Excavation of trenches in ordinary soil/ hard dense soil/ hard dense soil mixed with boulders/decomposed rocks/hard rock/saturated soil for laying pipeline below ground asper the L-section approved by the department. An minimum clear cover of 0.9 m shall generally be maintained.

(vi) Preparation of trench bed, where pipe is laid below ground in stretches having boulders/rocky strata.

(vii) Refilling & compaction of trenches.

(viii) Providing support structures such as saddle supports or portal frames for pipe laying above ground, wherever required.

(ix) Construction of thrust blocks at each deflection in horizontal and vertical alignment of pipeline exceeding 5 degree for vertical bends and 10 degrees for horizontal bends.

(x) The pipeline above ground shall be suitably clamped, to prevent floating of pipes in submerged conditions.

(xi) Interconnection of pipelines to existing pipelines, existing GLSRs including providing all specials, civil & mechanical works.

(xii) To repair damage to pipelines, electrical poles, telephone poles, optical fiber cables etc. and providing suitable structures for crossing the existing other rising mains during laying clear water mains.

(xiii) Providing, testing and installing all materials such as bends, tees, reducers with long radius, dismantling joints, insulating joints, rubber rings, flanges, nuts & bolts, rubber sheets etc. of required specifications for the installations.

(xiv) Providing anchor blocks wherever necessary.

(xv) Providing protection for foundations of pedestals/portals against soil erosion.

(xvi) Sectional testing of pipeline.

(xvii) Removal of defects in laying and jointing works of all pipelines, valves and specials.

(xviii) Compliance of all safety rules at work sites.

(xix) Making connection of new pipes to existing pipes in transmission and distribution as per directions of EIC.

(xx) Cleaning, Disinfections, testing and commissioning of all pipelines laid.

(xxi) Other ancillary works.

(xxii) Providing and fixing Barricading at site of work for restricting the general public at Crowded area and frequently running traffic as per the direction of engineer in-charge.

(xxiii) For NH/SH/railway crossings, the department shall apply to respective department for permission to carry out the crossing work. It shall be the contractors' responsibility to obtain approval from respective deptt. for such crossing work . In case the respective deptt. does not allow the contractor to do the work and carries the work themselves as a deposit work, cost of such work shall be borne by the deptt. and withdraw these work on the contractor scope.

(xxiv) Encasing with MS pipe of carrier main, as DI/MS pipe line or as per specifications of concerned department, shall be provided at all Railway/canal/NH or SH Road/drain crossing and drawing and specifications of concern department shall be adopted by contractor.

(xxv) It shall be sole responsibility of the contractor to obtain permission for Road/Rail crossing from concern authority by furnishing all details/drawing/design and undertaking etc. required for the same time to time. However department PHED may assist the contractor. Any lapse/delay occur to the project due to late approval and there of execution shall be the contractor's responsibility. The contractor shall be responsible for any damage occurred to the telephone lines, distribution/rising main water and gas pipe lines, sewerage pipe line, roads, drains while laying pipeline and shall be liable to pay the amount levied by respective department for the repair and / or damages so occurred;

(xxvi) The contractor should identify the number of crossings on National/State highways and district roads etc. The scope under this item includes all road crossings where pipelines are expected to cross any road as finalized by EIC.

(xxvii) Providing a suitable designed and approved scour-proof bed for crossing of pipeline below the scour depth of nallah, drain, canal or river. For pipe crossings of drains above ground, the invert level of pipe shall be kept 1 m above H.F.L / road level, using suitable support structures. The structures must be protected by suitably planned river training works. The crossing below the scour depth or above HFL has to be decided in co-ordination of the EIC. Detailed drawing of crossing arrangements proposed to be used shall be presented to Engineer-In-charge for approval.

(xxviii) The laying of pipe shall not obstruct the flow of water in the natural drains. The drains may be crossed under ground at scour depth with MS pipe in river crossing. The pipe shall be encased through pushing method and or as per specifications of concern department. The structures must be protected by suitably planned river training works.

(xxix) The contractor shall carry out surge analysis for all the pumping mains using IISC, Bangalore developed software and get the same approval by EIC. Based on the approval given by EIC, all the mechanical & civil work related to supply & installation of surge control accessories shall be carried out by the contractor. The Zero velocity Valves shall be installed in suitable RCC Chambers provided with manhole cover & locking, drainage, access arrangement. The work also include providing & fixing of pipe lengths, bends, tees, dismantling joint, nuts & bolts etc.

(xxx) The contractor is required to establish a field laboratory at each site office for ensuring the timely inspection of the material and works.

(xxxi) The contractor shall carry out all works civil and/or mechanical work which includes supply of specials, valves, tees, bends etc for interconnecting the proposed pumping mains under this contract. The pumping mains shall be connected to the outlet pipe from outlet chamber of pumping stations at their upstream and shall be connected to inlet pipe of existing/proposed GLSRs & CWRs.

(xxxii) The work shall include all other items & accessories not specified above but required to complete the work on turn key basis to achieve the intended objectives in safe, secure, reliable manner adopting best engineering practices

(xxxiii) The contractor shall take all safety precaution during execution of all work i.e. P/L, CWR, GLSR and civil work etc.

(xxxiv) The Lengths of various pipelines are provided in succeeding paragraphs, however, during execution, the lengths as mentioned below may vary. For payment and other purposes, the actual lengths of connected pipes excluding specials shall be used.

(xxxv) In the following locations, the DI pipelines are compulsorily to be provided:

i. In river or nallah or canal or drain crossings

ii. In road crossings and under traffic loads and where pipeline is to be laid below road carpet area

iii. When pipeline is to be laid above ground

iv. In thickly populated areas, as per directions of Engineer in Charge

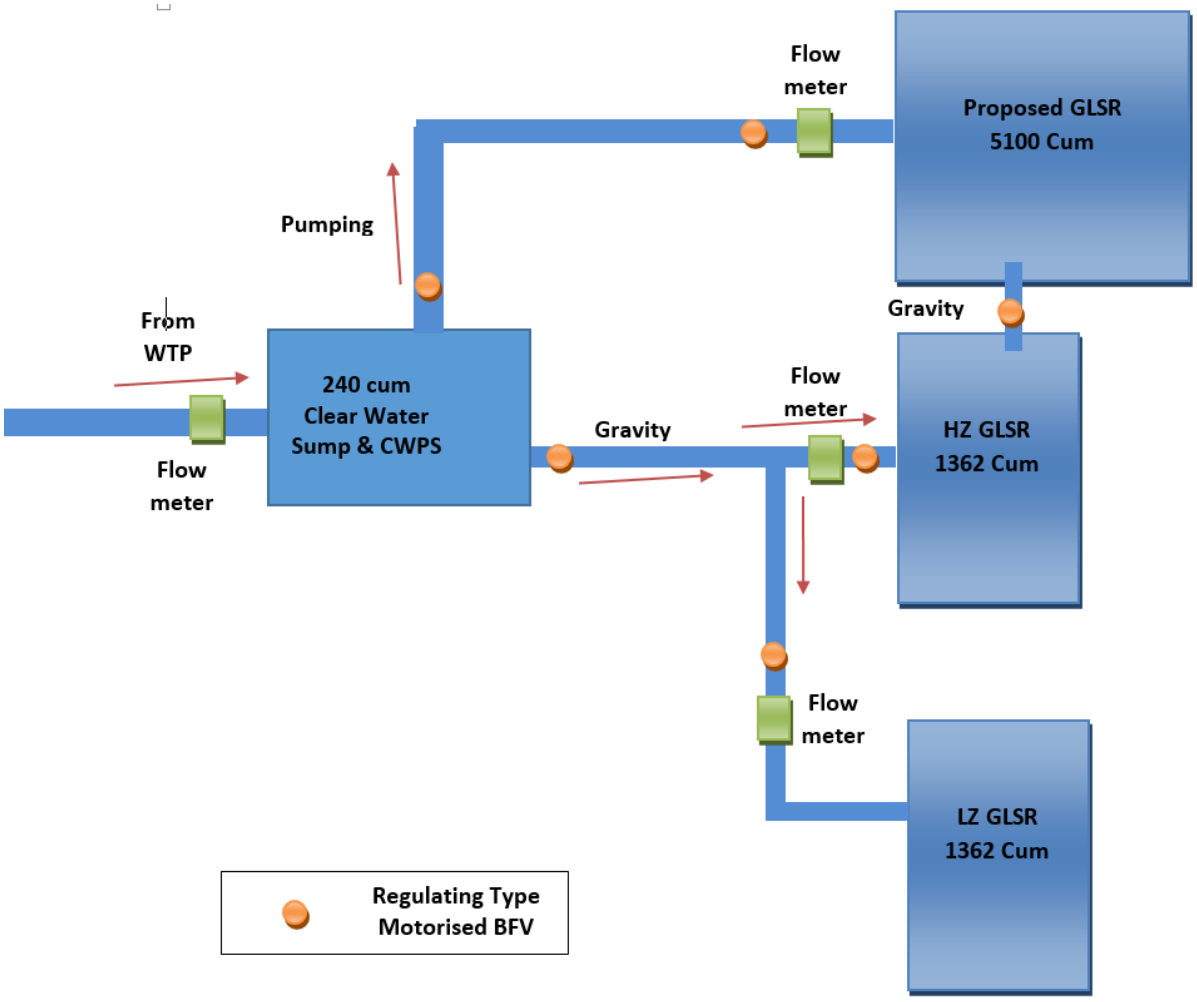
v. In rocky starata

2.5.1. **Ductile Iron (DI) Pipeline Work**

In existing system, Patel circle is being fed raw water from Dudh Talai RWPS via 2655 m long, 600 mm Dia MS pipeline. This 600 mm dia pipeline is to be disconnected at a distance of 1350 m from Dudh Talai RWPS and connected to proposed 600 mm DI K-7 pipeline for feeding raw water to proposed Machla Magra WTP. As the requirement of pipeline for Patel circle WTP is of 450 mm dia pipeline, a 1350 m long, 450 mm dia DI K-7 pipeline is to be laid and connected to remaining existing 600 mm Dia MS pipeline. The 1350 m long 600 mm diameter MS pipe being used for Machla Magra WTP is to be repaired in case of leakage or outbursts and pipe piece to be replaced if required at **no extra cost**.

The contractor is also to maintain existing pipelines supplying water to Dudh Talai WTP until new pipeline is laid under separate project. The scope of work also includes design and laying of pipeline for connection of 2.85 MLD WTP at Dudh Talai from existing 13.57 MLD WTP at Dudh Talai.

The work also includes connection of CWPS Machla Magra to High Zone and Low Zone GLSRs being feeded through gravity and pumping main to new 5.1 ML GLSR being constructed under this project. The typical layout for connection of CWPS to GLSRs is as below:



Cost of specials for pipe laying, interconnections is to be taken under scope of pipeline.

The details of DI pipeline proposed to be procured & laid under this project, as per the requirements & specification in this document, is as follows;

Details of Pumping Mains

Pipe No	From	To	Existing/ Proposed	Length	Pipe Material & Class	Dia
1.	RWPS Dudh Talai	JN-01	P	1350	DI-K7	450
2.	JN-01	WTP Patel Circle	E	1305	MS	600
3.	RWPS Dudh Talai	JN-02	E	1350	MS	600

4.	JN-02	WTP Machla Magra	P	130	DI-K7	600
5.	RWPS Dudh Talai	Dudh Talai 13.5+2.85	E	106	CI	450
6.	RWPS Dudh Talai	Dudh Talai 13.5+2.85	E	116	CI	300
7.	CWPS Machla Magra	5.1 ML CWR	P	35	DI-K7	500
4.	Inter Connection Work		P	600	DI K-7	250
				110	DI K-7	300

The summary of proposed pumping mains is as follows;

Diameter (mm)	Pipe Material & Class	Length of Porposed Pumping Mains
250	DI K-7	630
300	DI K-7	110
400	DI K-7	10
450	DI K-7	1350
500	DI K-7	35
600	DI K-7	130

Details of Distribution System

Distribution network is to be designed by the contractor for ABD Area, Udaipur. Main feeders from existing and proposed GLSRs are to be laid for 14 Nos distribution zones (31 Nos. DMAs). These main feeders are to be connected to zonal distribution network only at DMA inlet points. Due to large variations in ground levels in ABD Area pressure reduction valves are to be taken for each DMA for providing adequate pressure at tail end of distribution network. Under the project, complete distribution network of ABD area is to be covered with DI K-7 pipeline network. The work includes replacement of existing CI/MS/GI/UPVC pipelines with DI K-7 pipe network as per design of distribution network of ABD Area by contractor.

The distribution network is to be designed keeping 17 m pressure attail end of distribution except areas with very high ground level as per direction of engineer incharge.

The details of **existing** distribution pipelines in ABD Area is as follows:

S. No.	Pipe Material	Pipe Diameter (mm)	Length (m)
1	AC	80	10906
		100	8006
		150	5880
		200	4892
		300	1040
2	CI	80	6646
		100	7262
		150	8847
		200	6458
		225	1234
		250	5144
		300	3897
		350	1189
		450	2226
3	DI	100	15775
		150	4166
		200	3306
		250	2260
	TOTAL		**99134**

The feeders will be feeding various zones as per the details given below:

Sr. No.	Hydraulic Zone	DMA	Service Reservoir	Feeder (DI K-7)	Water Demand (KL/Day)
1	Zone-1	DMA-1	5.1 ML GLSR	600 mm Dia	535.50
		DMA-2	5.1 ML GLSR	600 mm Dia	547.61
		DMA-3	5.1 ML GLSR	600 mm Dia	541.19
		DMA-4	5.1 ML GLSR	600 mm Dia	775.28
2	Zone-2	DMA-1	5.1 ML GLSR	600 mm Dia	1546.21
		DMA-2	5.1 ML GLSR	600 mm Dia	789.65
		DMA-3	5.1 ML GLSR	600 mm Dia	1086.78
3	Zone-3	DMA-1	High Zone GLSR	450 mm Dia	1121.12

		DMA-2	High Zone GLSR	450 mm Dia	857.54
		DMA-3	High Zone GLSR	450 mm Dia	669.25
4	Zone-4	DMA-1	5.1 ML GLSR	600 mm Dia	780.04
		DMA-2	5.1 ML GLSR	600 mm Dia	1342.70
5	Zone-5	DMA-1	High Zone GLSR	450 mm Dia	792.42
		DMA-2	5.1 ML GLSR	600 mm Dia	985.80
		DMA-3	5.1 ML GLSR	600 mm Dia	256.27
		DMA-4	High Zone GLSR	450 mm Dia	641.50
6	Zone-6	DMA-1	High Zone GLSR	450 mm Dia	655.06
		DMA-2	High Zone GLSR	450 mm Dia	373.52
		DMA-3	High Zone GLSR	450 mm Dia	726.82
7	Zone-7	DMA-1	5.1 ML GLSR	600 mm Dia	911.32
		DMA-2	5.1 ML GLSR	600 mm Dia	559.90
8	Zone-8	DMA-1	5.1 ML GLSR	600 mm Dia	810.51
9	Zone-9	DMA-1	High Zone GLSR	450 mm Dia	381.92
		DMA-2	High Zone GLSR	450 mm Dia	362.08
10	Zone-10	DMA-1	Low Zone GLSR	400 mm Dia	953.75
11	Zone-11	DMA-1	Low Zone GLSR	400 mm Dia	581.90
		DMA-2	Low Zone GLSR	400 mm Dia	973.09
12	Zone-12	DMA-1	Low Zone GLSR	400 mm Dia	897.67
13	Zone-13	DMA-1	5.1 ML GLSR	600 mm Dia	1370.00
14	Zone-14	DMA-1	5.1 ML GLSR	600 mm Dia	317.06
		DMA-2	5.1 ML GLSR	600 mm Dia	285.53
	TOTAL (MLD)				**23.47**

Details of Proposed Distribution to be laid is as below:

Diameter (mm)	Material	Class	HWC	Length Meter
100	DI	K7	140	74,179
150	DI	K7	140	2,987
200	DI	K7	140	3,116
250	DI	K7	140	2,416
300	DI	K7	140	1,326
350	DI	K7	140	395
400	DI	K7	140	1,980
450	DI	K7	140	1,402
500	DI	K7	140	35
600	DI	K7	140	374
		Total		**88,210**

The scope of work includes interconnection of existing ESRs, SRs outside ABD Area being fed from Gulab Bagh WTP to Dudh Talai WTP. The work should be done without disrupting the existing supply system and as per the directions of EIC.

Work also includes dovetailing with ongoing/ sanctioned projects is to be done while matching it with pipeline to be laid under the project to avoid any duplicacy in the work.

2.5.2. **Butter fly valves:-**

The contractor has to provide, and test online butterfly valves of P.N. 1.6, including regulating type electricactuator with built in starter as per specification with dismantling joint of same diameter as that of pipe lines detailed below. All the valves to be installed at inlet of CWR/SR/WTP may be housed in one chamber of appropriate size, the drawing of which shall be got approved from EIC.

The detailes of butter fly valves to be provided installed and tested including supply, testing, installation of Dismantling jointing material such as rubber gasket, nut, bolt etc are as under.

S.No	Diameter pressure rating of B/F valve	Qty.
1.	Low Zone GLSR Inlet- 250 mm dia	1
2.	High Zone GLSR Inlet- 350 mm dia	1
3.	New 5100 KL Zone GLSR Inlet- 500 mm dia	1

4.	5100 KL GLSR to High Zone GLSR Interconnection-250 mm dia	1
5.	Machla Magra Clear Water Sump Gravity Outlet-350 mm dia	1

2.5.3. **Sluice Valves**

The Contractor has to Provide, install and test on-line resilient seated D/F sluice valves with dismantling joint/ of the same diameter as that of pipelineas detailed below. All valves to be installed at a particular junction may be housed in one chamber of appropriate size, the drawing of which shall be got approved from the EIC.

The pressure rating of valves shall be as per the design pressure at the point of installation but not less than PN 1.0. The locations of sectionalizing valves shall be proposed as per site conditions and shall be got approved from Engineer-In-Charge. The sectionalizing valves shall be installed in chambers with a telescopic dismantling joint and other specials.

The details of sectionalizing resilient seated Sluice Valves to be provided, installed and tested including supply, testing, Jointing Material such as rubber gasket, nuts, bolts etc, are as under.

S. No.	Diameter & Pressure Rating of resilient seated S.V	Qty. Pumping Main	Qty. Distribution	Total Qty.
1.	600 mm, PN 1.0		1	1
2.	500 mm, PN 1.0	1	1	2
3.	450 mm, PN 1.0	1	2	3
4.	400 mm, PN1.0			
5.	350 mm, PN1.0		1	1
6.	300 mm, PN1.0	1	1	2
7.	250 mm, PN1.0		5	5
8.	200mm, PN1.0		12	12
9.	150mm, PN1.0		19	19
10.	125 mm,PN1.0			
11.	100mm, PN1.0		39	39
12.	80 mm, PN1.0			
			Total	87

The contractor is also to install drain valves in distribution network at suitable points/locations for drainage of water in pipelines for maintenance purpose at no extra cost.

2.5.4. **Pressure Reducing Valves**

The flow form Machla Magra GLSRs to ABD area has a high head of while the supply to DMA requires only 25 m water head at the inlet point, thus, for controlling pressure, pressure reduction valves are proposed at inlet/ critical point of all 31 DMAs as per approval of EIC.

The scope of work includes Providing, lowering, laying, aligning, fixing in position and jointing in pipe line of DI D/F hydraulic (self-medium operated) operated diaphragm type Pressure Reducing valve, with the function to reduce higher upstream pressure into a preset lower downstream pressure. The valve shall maintain this pressure constantly regardless of flow-rate or upstream pressure fluctuations, including all material, labour, testing and commissioning as per Technical Specifications and as per direction of Engineer.

Providing & Installation of Pressure reducing valves of following sizes:

S.No	Diameter (mm)	Qty (nos)
	At Inlet of each DMA in ABD area	
1	100 mm	1
2	150 mm	17
3	200 mm	10
4	250 mm	3

These are tentative sizes and actual sizes are to be matched as per the actual designs and get approved by EiC.

2.5.5. **CI Dismantling Joints**

The scope of work includes providing, installation & testing of CI DIamnatling joints telescopic as per relevant standards. The CI Dismantling joints shall be of same size as that of associated sluice valve. The pressure rating of CI Dismantling joints shall be commensurate with associated Sluice Valve.

2.5.6. **Double Kinetic Air Valves**

The scope of work under this item includes providing Double Ball (Steel Balls) Kinetic Air valves with isolating sluice valves along with required connecting pipe, specials, clamps, jointing material etc and its installation, testing etc on pumping mains/distribution mains. The work will also include providing, testing & installation of respective size of kinetic air valves with isolating sluice valves. The air valves shall be placed as approved on the L-sections. The kinetic air valves with isolation sluice valves shall be provided at suitable interval and contractor shall show the location of the air valves on the L- section as per survey.

Number of Kinetic Air Valves as required under this contract for ABD Area Udaipur shall be as under:-

S.N.	Type	Diameter & Pressure Rating	Numbers
1.	Kinetic air valves	100 mm PN 1.0	1

Typical arrangement for installation of air valve has been provided in drawings attached with tender document.

2.5.7. RCC Valve Chambers

The work includes Construction of RCC Sectionalizing Valve Chambers at each location of sectionalizing valve along with providing manhole cover with locking arrangement, at least one MS ladder for access to floor of chamber and suitable pedestals for supporting valves and pipes. The chamber shall have suitable drainage arrangement to prevent accumulation of water.

Number of sectionalizing valves chambers as required under this contract shall be as under but shall not be limited to;

S. No.	Chamber suitable to House Sluice Valves of Diameter	For Pumping Main	For Distribution	Total
1.	Type – I For pipe up to 150 mm DI		62	62
2	Type- II for pipes 200-350 mm DI	4	15	19
3	Type – III for pipes 400- 600 mm DI	4	4	8
4.	Type- IV for pipes 600-700 mm DI	-	-	
5.	Air Valve Chamber	1	-	1
Total				**90**

Typical arrangement required is provided in drawings provided of this tender document.

2.5.8. Scour Valve Chambers

The work includes construction of scour valve chambers in ABD Area Udaipur. The works includes providing & installation of MS/CI/DI Tee at required location and installation of sluice valve with dismantling joint.

The locations of scour valves in rising pipe /Distribution line shall be proposed as per site conditions and shall be got approved from Engineer-In-Charge. The size of the scour valve shall be as approved by EIC (of suitable pressure rating, not less than PN 1.0). The scour valves shall be installed in chambers with a dismantling pipe and other specials. Minimum clear dimensions of the chamber shall be as shown in drawings of tender documents. The wall, roof and other structural members of the chambers shall be constructed as per design, which shall be got approved from the Engineer-In-Charge.

The chambers for scour valves shall be off-line and placed on the scour pipe. The provisions shown in the scour valve drawings are to be provided. In scour valve

chambers, a attached wet chamber shall be constructed with overflow facilities and pitching on the overflow sides for safety of the chamber.

2.5.9. **Dismantling Existing Sluice Valves**

The Work includes dismantling of existing sluice valves in the piping system as per directions of Engineer-in-Charge. The work includes following items;

- Excavation at location of existing sluice valve, if required.
- Stacking of all construction material and deposit all the material such as valve, dismantling joint, nuts & bolts and any other material recovered from site to USCL /PHED store
- Making reconnection as per site requirement including all material, specials etc complete in all respectto the satisfaction of Engineer-in-Charge
- Testing of reconnection for leakage
- Clearing site of all debris and making it good

2.5.10. **Making Connections with Existing Pipelines**

The scope of work includes making connections of pipelines laid under this project with the existing pipelines of DI which includes following works;

- ❖ Excavation for making connection
- ❖ Cutting of existing pipeline
- ❖ Providing & installation all required MS/DI/CI specials & Jointing Material such as joints, nut, bolts & washers, rubber rings, lubricants etc
- ❖ Testing of connection for leakage
- ❖ Making good the connection reinstatement of road surface to its original condition
- ❖ Clearing the site of any debris

2.5.11. **Consumer Water Meters**

The scope of work includes installation of water meters as per specifications mentioned in this document and as per following guidelines;

- In domestic connections, the replacement of non functional meters shall be taken up by New Standard Multi-jet, Class -B magnetically coupled water meter in horizontal position with super dry "dial and hermitically sealed conforming to IS 779-11994 or ISO 4064 with latest specifications with EEC/MID mark, along with (IP 68 protection with metallic can register) Meter with nut and nipple set. Warranty ten years, Endurance test conducted by FCRI.

- In Non-Domestic and commercial connections, the replacement of non functional meters shall be taken up by New AMR Multi-jet, Class-B magnetically coupled water meter in horizontal position with super dry " dial and hermitically sealed conforming to IS 779-11994 or ISO 4064 with latest specifications with EEC/MID mark, along with (IP 68 protection with metallic can register) Meter with nut and nipple set. Warranty ten years, Endurance test conducted by FCRI with latest technology (Like AMR/GPS/GSM) for accurate meter reading.

As per these guidelines, the work includes installation, commissioning, testing of

- For domestic connections - Standard Multi-Jet Class-B Magnetically coupled water meter,
- For Non domestic & commercial connections and Industrial connections - AMR Multi-Jet Class-B Magnetically coupled water meter
- The details of various connections under this project are as follows;

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Connection Type</th><th colspan="5">Connection Size</th></tr>
<tr><th>15 mm</th><th>20 mm</th><th>25 mm</th><th>32 mm</th><th>40 mm</th></tr>
<tr><td>1</td><td>Domestic Connections</td><td>18000</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Non Domestic Connections</td><td rowspan="2">1000</td><td rowspan="2">25</td><td rowspan="2"></td><td></td><td></td></tr>
<tr><td>3</td><td>Industrial Connections</td><td></td><td></td></tr>
<tr><td>4</td><td>Other Bulk Consumers</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

The contractor shall provide 2 nos of handheld devices at ABD Area Udaipurseparately for acquiring the water meter reading from these water meters. The contractor shall get approval for AMR module to be fitted with water meters and handheld devices from Engineer-in-charge. The meters shall be provided with 10 years warranty period.

2.5.12. **House Service Connections**

The work includes all earth work of excavation in all type of strata and road cutting for making house service connections from water supply distribution pipeline upto water meter chamber.

The work includes making house service connection from water supply distribution pipe line upto water meter chamber, with MDPE Composite pipes of 20/25/32 mm diameter below the ground of 15/20/25 mm G.I. Pipe class B above the ground including supply

and fixing of ferrules, Electrofusion tapping saddle for PE pipes/clamps for D.I/welded for G.I pipes, union end plug, compression fitting including all materials, labour, testing and commissioning as per technical specification and direction of shall the Engineer In-charge.

2.5.13. **Other items**

The Contractor shall provide all other items which are required to provide the required functionality for pipeline portion of the project and to fulfill the overall objectives of the project. No separate payment for these items shall be made and cost of these items will be treated as included in quoted cost for other items in this section.

2.6. **Pumping Station –Electro Mechanical Works**

The works included are as defined below but shall not be limited to:

2.6.1. **Submersible or Conventional Vertical Turbine Pumps**

The work includes providing and installation of pumps includes design, manufacture and testing at manufacturer's works, packing for shipment, delivery to the site, supply, unloading, storing, complete erection, pre-commissioning tests, trial runs and commissioning at all thepumping stations. 100% standby pumps shall be provided for each section of rising main. The headworks-wise details of pumps to be provided and installed for each section of rising main is given below.

The Pump Duty conditions for various pumps to be replaced/installed under this project are as follows;

S.N	Location of Pump	Pumping To	Duty condition proposed		Number of pump
			Cum/hr	Head (mWC)	
1	Dudh Talai RWPS	Machla Magra WTP	1078	54	1+1
2	Dudh Talai RWPS	Dudh Talai WTP	957	59	1+1
3	Dudh Talai RWPS	Patel Cirlce WTP	439	37	1+1
4	Machla Magra CWPS	5.1 ML GLSR	688	24	1+1

The Pumps to be installed at Machla Magra CWPS are to pump water to new 5.1 ML GLSR. The Existing High Zone and Low zone GLSRs are to be feeded by gravity.

THE DUTY CONDITIONS GIVEN ABOVE ARE BASED ON DEPARTMENT"S CONCEPT. THE CONTRACTOR SHALL VERIFY THESE BASED ON THE TOPOGRAPHICAL SURVEY AND DESIGN AND SUBMIT THE DUTY CONDITIONS FOR APPROVAL OF THE DEPARTMENT ALONG WITH THE SYSTEM CURVE FOR HIGH AND LOW LEVEL IN THE SUMP/WATER BODY. NO EXTRA PAYMENT SHALL BE ADMISSIBLE FOR ANY CHANGE IN DUTY CONDITIONS.

PUMP TYPE

Single-stage / multi-stage, Submersible Vertical Turbine pumps or conventional vertical turbine pumps shall be installed. Preference shall be given to pumps of higher efficiency. For this purpose, please refer to clause no. 11.1.4 of CPHEEO"s water supply manual for selection of pumps. The efficiency of pump should be minimum as calculated from the Fig. 11.1 of the CPHEEO"s water supply manual. Pump shall conform to specifications and standards furnished in specifications. For pumps of 15 KW and below ratings, if synchronous speed of 1500 RPM is not available in approved makes then, synchronous speed of 3000 RPM may be considered.

PUMP MOTOR

All motors for pump shall be suitable for 0.415 kV, 3 phase, 50 Hz power supply. All motors shall be of suitable kW ratings and energy efficient. The motors selected should be as per latest circulars and directions of the department with regard to energy saving.

2.6.2. Sluice Valves

The work includes providing, lowering, laying, alinging, fixing in position on suction & delivery pipeline, manually operated Resilient Seated D/F Sluice valves of approved make & design standard complete (including jointing & jointing material) including all material, labour, testing and commissioning along with pipe line as per Technical Specification & as per direction of Engineer.

For each pumpset, one number of sluice valve is to be installed on suction pipe and one number of sluice valve is to be installed on delivery pipe. The size of valve shall be similar to that of respective suction/delivery pipe and no size reduction is allowed.

2.6.3. Butterfly Valves

The work includes providing, installation, testing and commissioning of butterfly valves including electric actuator. The valves shall be with integral body seat and bubble tight shut-off type, suitable for ON-OFF & regulated operation. Butterfly valves shall be of double eccentric and resilient seated type as per BS EN 593, BS 5155 and IS 13095.

For each pumpset, one number of electrically actuated butterfly valve is to be installed on delivery pipe. The size of valve shall be similar to that of respective delivery pipe and no size reduction is allowed.

2.6.4. Expansion Bellows

The work includes providing, installation, testing and commissioning of Stainless steel AISI 304 Expansion bellows with tie rods as per technical specifications and layout drawings including jointing material like nuts, bolts, rubber gaskets etc. complete in all respect as per technical specification and as per direction of the Engineer.

For each pumpset, two number of expansion bellow is to be installed on delivery pipe and one number on suction line of each pumpset. The size of bellow shall be similar to that of respective delivery pipe and no size reduction is allowed.

2.6.5. **Dual Plate Check Valves**

The work includes providing, lowering, laying, aligning, fixing in position and jointing in pipe line, dual plate check valves as per API:594 and API:598 (including jointing and jointing material), including all material, labour, testing and commissioning as per Technical Specifications and as per direction of Engineer.

For each pumpset, one number of dual plate check valves is to be installed on delivery pipe. The size of valve shall be similar to that of respective delivery pipe and no size reduction is allowed.

2.6.6. **SUCTION AND DELIVERY SYSTEM DETAILS**

The General arrangement of suction & delivery piping system at all the pumping station shall be as follows;

- Individual suction lines of the pumps shall be provided. The suction lines shall be directly inserted inside Lake at maximum drawl level.
- On the delivery side, it will have an enlarger, a dual plate check valve, onesluice valve, one motorized butterfly valves with two stainless steel expansion bellows, a pressure gauge.
- On the common delivery header (of 2 pumps), one kinetic air valve, sluice valve with dismantling joint, pressure switch, full bore electro-magnetic flow meter shall be provided. The flow meter shall be installed inside the pump house. The air valve can be installed outside on a pillar.
- All valves and specials on suction side of pumps in pumping station shall be of minimum pressure rating of PN 1.0 and that on delivery side PN 1.6.

However, the contractor shall prepare the P&I diagram for each pumping station & got it approved from EIC.

The Piping system shall be of following material & specifications;

- The suction and delivery piping systems in the pump house and from the clear water reservoirs shall be of MS pipes with welded bends and flanges for interconnections and connections of the pumps and valves.
- The thickness of MS Pipe shall be not less than 6mm/8mm.

- The MS pipes and specials used in the pump houses shall have food grade epoxy coating with primer on the inside surface and fibre- glass bituminous coating (Total thickness of 2.5 mm) on the outer surface, as per relevant standards.

The sizes of the suction and delivery header pipes shall be designed by the contractor as per the prescribed velocity range and submit the same for approval of the department.

2.6.7. **Electric Transformers**

The work includes supply, receiving, storing, inspection, handling , assembling ,installing in correct aligned position, effecting proper connections, testing and commissioning of out door type oil filled transformer confirming to IS 2026(Part 1-5) requires BEE star level certification from bureau of energy efficiency as detailed below;

- At Dudh Talai RWPS

S.No.	Particulars	Qty	Unit
1	1000 KVA	2.0	Nos

- At Machla Magra WTP

S.No.	Particulars	Qty	Unit
1	315 KVA	2.0	Nos

The work includes construction of foundations as per designs approved by EIC, drainage arrangement, oil collection arrangement, stone ballast, fencing, cabling, connections, fire wall etc in all respect.

The transformers at Dudh Talai RWPS will receive power from ring main unit with 2 isolators and will be connected to LT MCC Panel via over head bus bar.

At CWPS Machla Magra, electrical supply will be from common transformer for Machla Magra WTP and CWPS Machla Magra.

2.6.8. **LT MCC Panel**

The work includes providing, installation, testing and commissioning of LT MCC panel housing motor starters, relays, MCB/MCCBs, bus-bar for all pump sets including all internal cabling and cable/bus-bar, capacitors required to achieve a power factor of 0.98 etc, complete in all respect as per the scope of work & specifications for the following location as per SLD provided in TD. However, looking at the small rating of pumps, individual separate capacitors may also be provided with each of the pumps. Decision of EIC shall be final in this regard.

The LT MCC Panel shall have :

- Incoming – 2 MCCB 50 KA with 2 sets of metering having ammeter with selector, voltmeter with selector, multifunction meter and indicating lights.

- Outgoing – starter DOL up to 22 KW, star delta above 22 KW and upto 50 KW, Soft starter for above 50 KW motors; with motor protection relay having overload, phase loss, reverse phase, locked rotor, stalling, local remote push buttons and on-off trip indicating lights.

- The soft starters shall be provided along with the following accessories;

o MPCB of suitable rating

o V & I Metering of reputed make.

o Indication of Phases R/Y/B, Motor On/Off/Trip.

o Protection –Overload, Short Circuit, Phase failure, Under Voltage and Over voltage.

The LT MCC panel shall house the ACB/MCCB, Voltmeter & ammeter, to the main feeder and MCCB/MCB to individual Panel Feeders, indicating lights etc., shall also be provided for the motors To be installed in this contract, mulifunction meters on the main feeder and energy meters on individual motor feders to measure electrical power consumed with each pump set. The reading of these meters shall be sent to the PLC System for energy audit.

S.No.	Particulars	Qty	Unit
1	Dudh Talai RWPS	2	Nos.

At Dudh Talai RWPS, pumps are to be installed in PS-1. Due to space constraints, the panels are to be installed in 2 parts. Panel no. the installation procedure will be as below:

1. Panel-1 will have 5isolators with 2 nos. connected to over head bus bar from transformers, 2 no. for pumps pumping water to Dudh Talai WTP and 1 no. isolator for connection to Panel-2 via over head bus bar.
2. The Panel-2 is to be connected to panel-1 via an overhead bus bar. 5 isolators are to be provided in Panel-2 and connected to Pumps for WTP Machla Magra and WTP Patel Circle.

2.6.9. **Ring Main Units**

The scope of work includes installation of 3 nos. ring main unit. 2 no. RMUs are to be installed with 1 isolator and 2 outgoing VCBs and 1 no. with 1 isolator for incomer and 2 outgoing isolators as per the specifications. At Dudh Talai RWPS, existing electrical supply is through a two pole structure supplying power to RWPS and UIT campus. This two pole structure is to be dismantled and the cost will be beared by the department including

laying an underground power feeder for Dudh Talai RWPS and UIT Campus. 1 no 1 isolator is to be connected to power feeder for UIT campus and 2nd to the meter room of Dudh Talai RWPS. 2nd ring main unit is to be installed before the transformer being to be installed under this project. Incomer from meter room is to be connected to ring main unit isolator and outgoing VCBs are to be connected to the transformers.

At Proposed CWPS and WTP at Machla Magra, 1 no. ring main unit with 1 isolator and 2 VCBs is to be connected for transformer protection.

2.6.10. **Power & Control Cables**

The scope of work includes providing, laying 185 sq. mm 3 core XLPE insulated / P.V.C. sheathed cable of 11 KV grade with aluminium conductor Armoured of IS:7098-I/1554-1 approved make in ground as per IS:1255 including excavation of 30cmx75cm size trench, 25 cm thick under layer of sand,IInd class bricks covering, refilling earth,compaction of earth, making necessary connection, testing etc for connecting Ring main unit to meter room and from meter room to 2nd ring main unit and then to transformers for pumps installed under this project.

The work also includes supply,Installation, Testing and Commissioning of 3/3.5/4.0 core 1.1.Kv/ 3.3 kV LT/HT cables, control cable/ Data cable, cable trays, lugs etc as per scope & specification at all Pumping Station and in ABD Area Udaipur for all pumps & instruments installed under this project.

2.6.11. **Local Push Button Stations**

Local push button stations shall be provided on each pump set /Motorized valves, for control of non-reversible (pump sets) andReversible (motorized valves) motors. The pump set motors LPB shall be provided with ammeters.

2.6.12. **Earthing System**

The work includes providing Earthing system as per relevant Indian Stadards for complete H T/ LT systems.The work includes all required material, labour, civil works etc. The contractor may utilize the existing earthing arrangement in existing pumping stations only after approval of EIC.

2.6.13. **Variable Frequency Drive (VFD)**

The work includes providing6 nos. heavy duty Variable Frequency Drives of 1050 KW at Dudh Talai Pumping Station of approved make & design standard complete including all material and labour as per Technical Specification & as per direction of Engineer.

Supply erection testing and commissioning of Heavy Duty Variable Frequency drive for 1050 kW Submersible Vertical Turbine/ Centrifugal Pump. Overloading: 150% of rated

current for 1 minute every 5minutes and 180% of rated current for 3 seconds every 30seconds.Ambient Temperature: 50 Degrees. Built in DC Choke to suppress harmonics. Built in 10k steps capacity of PLC.

2.6.14. **Active Harmonic Filters**

Active harmonic filter are to be provided along with APFC panels for neutralization of harmonics in real time, balancing unbalanced current and fine tuning power factor thus decreasing power losses due to heating in cables, transformers etc. created by harmonics, and saving enery by increasing power factor.

2.6.15. **Any Other Items**

All other items, accessories not specified but essentially required to complete of the work on turn key basis. Some of the items included in the Scope of work for Dudh Talai RWPS are as follows:

1. Panel for main lighting distribution board for pumping station building, outdoor lighting, building light and allied loads.
2. Providing exhaust fans for proper ventilation and restrict the temperature rise to less than 5°C above ambient.
3. Providing lighting fixtures along with cabling, distribution boards, switches and other accessories. The work shall include but not be limited to:
    I. Electric poles with LED lights all around the building outer area and the approaches from pump house, along the internal campus road, along the boundary wall, on the main gate and other important areas.
    II. Providing lighting fixtures at respective pump/motor floor areas, switchgear rooms, control room, office areas, lobbies, staircase and other areas. LED lighting shall be proposed for energy saving. Providing AC in control room of the SCADA system.
    III. Fans and coolers in office room
    IV. Installation of lightening arrestor

2.7. **Reservoirs**

2.7.1. **General requirement for Reservoirs**

The following submissions are required for approval:-

a) Submission of lay-out plans with site contour plan and site grading levels and plinth protection works for approval of EIC.

b) Submission of data sheet and samples of materials proposed for use in the structure.

c) Submission of Quality Assurance Plan and time schedule for approval of Engineer-in-charge.

d) Submission of samples of material equipment(s) for approval.

e) Submission of data sheet for equipments for approval.

No separate payments will be made for the reconnaissance, preliminary investigations, surveys, inspections, plinth protection, site clearance etc. They shall be included in the lump-sum rate.

The Contractor shall design all liquid retaining structures using the IS1893 (Part 2):2014 – Criteira for Earthquake Resistant Desing of Structures (Liquid Retaining Tanks).

The Contractor shall be fully responsible for Technical suitability of design, soundness of the construction, structural safety and water tightness of the structure based on the specifications, sound engineering practices and latest IS provisions.

The scope of work shall includes following:

i. Construction of reservoirs as per the provisions given in the "Specifications for civil works".

ii. Supply and installation of puddle collars and duck foot bends for installation of inlet, outlet, washout and overflow pipes.

iii. Supply and installation of double flanged CI/DI pipes for inlet, outlet, and washout (scour) and overflow with specials with minimum sizes as provided in reservoirs list provided elsewhere in this document.

iv. Interconnection of the inlet pipes to the feeder mains with pipe of equal size using CI/DI double flanged pipes and required specials.

v. Interconnection of outlet pipes from the SR to the feeders for zones connected with SR.

vi. Providing Laying & jointing of all interconnecting pipeline of inlet & out let pipes. The pipe sizes shall be corresponding to the incoming or outgoing pipes as the case may be.

vii. Providing & installation of at least two resilent seated D/F sluice valves on each outlet, one sluice valve on washout pipe for each reservoirs. The sizes of the valves shall be equal to that of the main on which they are to be installed. One of the Sluice Valve on out let should be fitted with electrical actuater and should be electrically operated and controlled through SCADA.

viii. Providing & installation of motorized butterfly valve with regulating type actuator at the inlet of each SR. The motorized valve will act as flow controllers for upstream flow.

ix. Interconnection of the overflow pipe to the distribution or the outgoing feeders as per the approval of Engineer-in-Charge using one sluice valve of size equal to the size of overflow pipes as provided in reservoirs list provided elsewhere in this document, CI/DI double flanged pipes and required specials.

x. Providing scour/washout pipes up to suitable length to drain the water away from the structure in an environmental friendly manner, using a sluice valve equal to

the size of washout pipe as provided in reservoirs list provided elsewhere in this document, CI/DI double flanged pipes and required specials.

xi. Providing float valve with auxiliary float in each CWR and SR. The size of float valve shall be same as of Inlet pipe. The pressure rating of valve should be in accordance to the maximum designed pressure.

xii. The washout pipe will be of 150 mm dia. for all the CWRs/GLSRs.

xiii. Providing water level indicator as per specifications given in the chapter of "Specifications for Civil Works" for all reservoirs.

xiv. An alarm should be provided so as to give a hooting sound when CWR is about to become empty.

xv. Providing a portable de-watering pump having discharge 10 Cum/hr and head of 10 meter at each CWR to drain out the water from washout chamber.

xvi. Excavation for all structures including working spaces, trench excavation for pipes & other ancillary works in all sorts of soils, refilling & disposal of surplus earth at suitable site & dressing as per direction of Engineer-in-charge.

xvii. Providing plinth protection works as per specifications and approved drawings for all reservoirs.

xviii. Providing access to the top and inside the reservoir as per the specifications given in the chapter of "Specifications for Civil Works".

xix. Providing ventilation for the reservoir as per the specifications given in the chapter of "Specifications for Civil Works".

xx. Providing manhole/headroom for access inside the reservoir.

xxi. Providing 25mm diameter GI pipe in two rows in 50x50x6mm angle iron railing along the top of reservoir, on the sides of the staircase and balcony, and at other suitable points for the requirement of safety of maintenance and execution staff.

xxii. For each SR, Providing a bypass arrangement to connect the incoming rising main to the outgoing distribution line so as to enable supply to the consumers through direct pumping in case of shut down of SR.

xxiii. All MS work shall be epoxy painted. The inner surface (soffite) of the Top Dome of CWR/GLSR shall be painted with two coats of suitable anti-corrosive food-grade epoxy coating. Similarly the inside of the vertical wall of CWR/GLSR shall also be painted with the same in 1.0 m height at the top of vertical wall.

xxiv. The inside surface of CWR/SR shall be finished with plaster in CM 1:4 and using water proofing compound as per manufacturer's recommendation. The outer wall and surface of tanks above ground shall be painted with cement paint of approved shade.

xxv. Testing of tank for water tightness and structural stability by filling it with water and in accordance to the procedure laid down in tender document as per I.S.S.

xxvi. Painting the metallic surface with primer and enamel paint. Putting slogan on tank as per direction of EIC.

xxvii. Final clearance of site before handing over the work, including leveling of earth and disposal of surplus earth as per directions of the Engineer-in-Charge.

xxviii. The submission of as built drawings.

The responsibility of the contractor will also include preparation & submission of drawings and designs, execution & testing of all works specifications stipulated in the tender document. The design & drawings of CWRs/SRs shall be got approved from MNIT, Jaipur or any other Engineering College as per directions of EIC before submitting the same to the department for approval.

Ancillary works

The works required are as listed below but not limited to:

- Construction of approaches to all CWR/SR sites. The approaches shall be made of WBM of 2.4 m width where slope is less than 1:15 and of cement concrete steps of width 1.2 m in M15 where slope is more than 1:15, from nearest road point.
- Site grading and plantation of CWRs/SRs campus areas.

The Contractor shall be fully responsible for the soundness of the construction, structural safety & water tightness of the structure based on the specifications, sound engineering practices, and latest I.S. provisions.

DETAILS OF NEW SERVICE RESERVOIRS

The scope of work consists of construction of new rectangular GLSR of minimum capacity 5100 KL at Machla Magra with partition wall for providing gravity water supply to various distribution zones of ABD Area. Minimum LWL of the GLSR is to be kept at RL 642 m for providing minimum 17 m terminal pressure at tail end of distribution network. The work includes providing inlet, outlet, washout, overflow valves, excavation, footing and complete work in all respect as per the directions of EIC.

2.7.2. Any other Items

All other items, accessories, work not specified but essentially required to complete of the work on turn key basis.

2.8. Water Treatment Plant

2.8.1. Scope of Work:

At present ABD area Udaipur is feeded water from Dudh Talai WTP, Gulab Bagh WTP and Patel Circle WTP. Gulab Bagh WTP is in dilapidated condition and is to be abandoned by PHED. A dedicated WTP of minimum clear water output capacity 23.47 MLD is proposed to be constructed for supplying 24x7 water to ABD area, Udaipur city. The WTP shall be constructed at Machla Magra Hillock near existing High Zone and Low Zone

GLSR. Unless and otherwise specifically mentioned all components of the filter plant shall be constructed for raw water inflow of 23.71 MLD (22 hours working) (minimum output capacity to be 23.47 MLD in 22 working hours). The layout plan of treatment Plant site is to be designed for the ultimate output capacity of 23.47 MLD only and concept drawings prepared accordingly.

The conventional water treatment plant of 23.71 MLD input capacity (22 Hour Working) (minimum output capacity to be 23.47 MLD in 22 working hours) based on coagulation, flocculation and clarification followed by Rapid Gravity filters and sludge disposal is to be constructed at near WTP site, as per the specifications given in the bid document. Alternatively the Tube Settlers/ Clariflocculators, Filter Beds, Backwash Arrangements, and Backwash Reservoir shall be constructed. All Mechanical, electrical and electronic equipment shall be provided, unless otherwise specified so as to enable installation and functioning of the instrumentation; PLC and the SCADA systems. The input water turbidity for the treatment plant design shall be taken as 1 to 500 NTU. Other chemical parameters are as follows:

PH	: 8
Total alkalinity	:130-140
Total hardness	: 140-150
Total dissolved solids	: 240-300

The maximumnumbers of filter beds shall not more than 4.

Along with the treatment plant the contractor is required to construct the administrative block, chemical house, chlorine scrubber, waste water recycling system etc. as detailed herein after. The building planning shall be done to give good aesthetic look for which necessary architectural planning shall be done. The specifications given for the construction material are the minimum specifications and can be upgraded as per the requirement of site. The contractor shall execute all works in accordance with the terms and conditions of the contract with good engineering practices and specifications given in the bid document.

Except the drain valves to flash Mixer; Inlet Chamber; Tube Settler/ Clariflocculator; drainage sump or Filter beds, all gates and valves shall be electrically operated. All electrically operated valves/gates used in the plant shall be provided with a manual operation facility and a local bush button station / local control console nearby, for operation of actuators.

2.8.2. **Extent of Work**

The extent of work is to treat raw water of Pichhola Lake throughout the year so as to ensure treatment of 23.71 MLDof raw water (22 hour working) (minimum output capacity to be 23.47 MLD in 22 working hours) of specified quality with filtration losses not more

than 4% and considering recycling of backwash & Tube Settler/ clariflocculator underflow, the net losses shall not be more than 1% of raw water treated. The work also includes construction of approach road and LED lighting along the approach road for WTP.

All the components of the plant shall be designed for 33% of hydraulic over loading.

The scope of WTP includes but is not limited to, the conceptualization, detailed design including hydraulic; process; equipment design; development, and preparation of detailed plant working drawings for process; civil; electrical; structural; mechanical; instrumentation & Control system, designing a suitable logic for operation of the Treatment Plant, preparation of design report, manufacture and testing at places of manufacture, painting, packing, transport, delivery, supply, storage, erection, building-in, setting to work, commissioning, testing, painting and finishing after erection of the complete plant required for the Water Treatment Works, including pipelines, pumps, pumping installations, dosing and metering pumps, blowers, compressors, machinery, apparatus, flow meters at various installations, station pipe work, lifting, handling and ventilation equipment, electrical equipment, instrumentation (SCADA operative system withPLC), control, lighting systems, earthing and lightning protection systems, materials, articles, fittings and accessories, ancillaries, ancillary works, enabling works of all kind and nature required for installations of the highest possible operative standards and for compliance with the standards prescribed in the specifications. Safety operation such as chlorine leak detection, start of fans and ventilation & sprinkling system in chlorine room or rooms in which hazardous chemicals are stored, start of audio alarm system and operation involved in saving of water or any other operation considered necessary by the contractor. All the automation operation of system wherever provided shall have a manual override.

In addition to the laboratory equipments, the contractor shall provide an indicative panel for the raw water, and filtered water in the laboratory. Online turbidity & pH meters shall be provided at inlet channel and online turbidity, residual chlorine & pH meters in clear water channel/pipe leading to Clear water sump. The turbidity & pH meters shall also be used to regulate the chemical dosing.

The contractor shall also consider providing arrangement for automating operation of any other unit required as per the logistics of treatment and control process, not specified here.

Pumps, motors, station pipe work and all accessories necessary for sludge and wash / waste water drainage systems for drainage of all the treatment units as required shall form a part of the Scope of Work.

Construction of Clear water sump and any other civil works required as defined in scope.

Installation of clear water pumps and necessary electromechanica, instrumentation and civil works as defined in scope.

2.8.3. **Water Treatment concept**

When the water treatment plant is operated at an output varying within the normal operating range (20% to 100% of rated output), the quality of the filtered water from individual clarifier, filter beds, the combined filtrate and the clear water reservoir outlet shall comply with the requirements stated under this Contract.

The raw water quality and the required treated water quality call for the following treatment:

a. Pre-chlorination
b. PACl, and other chemicals dosing
c. Coagulation/flocculation/settling with Tube Settlers/ clariflocculators.
d. Rapid sand gravity filtration, constant rate, rising level (influent flow splitting type)
e. Post Chlorination.
f. Recycling of waste water

The Contractor shall adopt this process but he is free to choose within the allocated site the layout, alignment, dimensions, levels, etc. according to his concept for which he makes an offer. Design parameters to choose the dimensions shall not be lower than average of specified range in water supply manual. The Tube Settlers are viewed as favorable alternative for clariflocculator as the turbidity level of raw water from Pichhola Lake is very low and its applicability due to space constraints. The contractor is to decide between tube settlers and clariflocculators based on design and space restrictions.

The head loss in the treatment plant between the water level in the inlet chamber and the water level in the clear water reservoir must not exceed 4.0 meters.

Apart from the quality guarantees, as stipulated in specifications for Filter Plant, the contractor has to guarantee that the total losses across the filter plant is not more than 4 % of raw water treated and considering recycling of backwash & Tube Settler/ clariflocculator underflow, the net losses shall not be more than 1% of raw water treated.

2.8.4. **Major Components of Work**

2.8.4.1. **General**

All elements of treatment plant construction will include design, manufacture, pre-dispatch inspection, supply, storage, installation, pre-commissioning tests, commissioning and trial run, and the operation and maintenance of equipment, automation and measuring equipment and civil works. The main components shall be as follows:

2.8.4.2. **Earthwork in Excavation**

As mentioned earlier, Machla Magra WTP is to be constructed on Machla Magra Hillock. The contours are very steep at some points and there is also factor of space constraint.

Thus, the excavation work shall be done in a proper and planned manner. Different WTP units are to be constructed at levelled terraces as per required ground level. Layout plan for reference is given at drawing number **PHED/ RAJ/ AMRUT & SMART/ UDZ/ TS/ WSS/ 04** in Volume III of Tender Document. The work will include cutting and backfill work in blasting prohibited area containing both soft and hard rocks.

2.8.4.3. **Clearing**

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Engineer-in-charge. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter / materials before fill commences.

Also the scope of work includes clearing the area along existing approach road and its extension as per specifications and directions of engineer incharge.

2.8.4.4. **Cascade Aerator**

Cascade aerator shall be provided with maximum TWL at RL 634.375 m to reduce turbidity of raw water. Raw water from Dudh Talai RWPS will be feeded in Cascade Aerator. Minimum of 5 nos. of steps are to be provided in the aerator. From the aerator launder, water will flow through pipeline to Inlet Chamber. The inlet pipe to the cascade aerator shall be provided with a valve U/s of inlet pipe for flow regulation. The valve shall be electrically operated. The electromagnetic flow meter installed at inlet of cascade aerator shall have a local display unit and shall be connected to the PLC system of treatment plant. For this suitable necessary instrumentation and I/O, communication cables etc. shall be installed.

2.8.4.5. **Inlet and Distribution system**

Inlet and distribution system shall comprise of an Inlet chamber, an inlet raw water pipe with one electromagnetic bulk flow meter and one mechanical flow meter, mixing arrangement for chemicals required for treatment and for pre-chlorination, a distribution chamber (if nos. of Flocculators/ Clariflocculators are more than 1 in numbers) and flash mixers.

In the inlet chamber a ladder shall be provided for access for maintenance. The chamber shall also be provided with a minimum 100mm manually operated sluice valve required for drainage during maintenance. The overflow weir shall be constructed with the campus drainage system to drain the excess inflow away from plant.

The pH and turbidity meters installed in Raw water pipe shall have a display panel in Laboratory and shall also be connected to the treatment plant PLC system.

A sampling pipe to take raw water for water quality analysis shall be provided. Sluice gates shall also be provided at the entry point of pipe and flash mixer.

The approach to inlet chamber from filter complex, all along the main raw water channel upto flash mixer and the walkway from flash mixer to Tube Settler/ clariflocculator shall be provided with walkways of minimum width 0.9m with MS railing etc. required for ease of maintenance and access.

2.8.4.6. **Flash Mixer**

A mechanical flash mixer shall be provided connected to the raw water inlet and measuring channel. The blades of the flash mixer paddles shall be placed at suitable depth so that even during one third of the nominal flow, the paddles are completely submerged. The outlet pipe from flash mixer shall be taken to the flocculator from the bottom of flash mixer. The Flash Mixers will be of reinforced cement concrete. The flash mixer will be equipped with an impeller type high speed mixer.

2.8.4.7. **Clarification**

The clarification works shall comprise of Flocculation zone followed by Tube Settlers or clariflocculators. The Tube Settler/ clariflocculators arrangement based on a central feed and flocculation and clarification or flocculation units followed by high rate tube settlers in hopper bottom clarifiers are envisaged as part of this work. Suitable periphery weirs shall be provided for collecting the supernatant (clarified water) in the Tube Settlers/ clariflocculators. Irrespective of the technology adopted, the responsibility of attainment of output parameters shall be solely of the contractor.

Mechanical, electrical, instrumentation & all other equipment, accessories including scrapers, sludge removal arrangement, sludge bleeding valves, drain valve (if at level different from sludge bleeding valve), walkways, stairs, railings, clarified water channel to the main channel to filter beds, all mechanical, electrical and instrumentation/automation/ PLC operation system equipment for rotating bridge, peripheral rail, drives for Tube Settlers/ flocculators and all instrumentation and control equipment, I/O ports for transmission of data to Instrumentation Panel and arrangement for by-passing the Tube Settlers/ clariflocculators, operation of sludge bleeding valves/gates etc. are also part of this Scope of work. Sampling points/ports, Pipes/channels between mixing chamber and Tube Settlers/ clariflocculators shall also be provided under the scope.

2.8.4.8. **Filters and Filter House**

Rapid Gravity beds shall contain no more than 4 nos. (2 twin beds), all distribution channels, pipe gallery, outlet weir, clear water channel and sump, control gallery, observation platforms, walkways, stairs, railings, control valve/gates, the instrumentation control equipments, back wash water tank with backwash pumps and air blowers shall be provided under the Scope.

Facility for modulation of inlet gates/valves to filters in accordance to the inflow rates so that all filter beds other than those under backwash are uniformly loaded is also to be provided. The underdrainage system should be of Vee Wire type for high filtration rate and decrease in head loss and prevention of media loss.

Differential Pressure Transmitters for head loss measurement shall be provided for selection of the filters for backwash on basis of head loss across the filters and subsequent sequencing of air/water and other back washing cycles through operation of respective valves/gates. The filter beds shall be open to sky and the operating platforms shall be covered.

The operation of backwash valves, air valves and blowers shall be automated in reference to head loss through filters. Automation shall also be provided for start/stop of back water pumps as per available water in back wash tank. Each filter bed shall be provided with equipments for manual operation of backwash system and a Common local control console with a distributed PLC I/Os and MMI for operation of back wash of filter bed(s). Necessary drainage/dewatering arrangement must be made in all units of filter plant.

The back wash water/drainage from the filter unit and other units as per the design shall be collected in a chamber which shall be well connected be drained the waste away from the campus at a suitable point approved by Engineer in Charge.

Overflow from all units shall be connected suitably to a drainage system. No hindrance to plant operations shall be permitted due to any overflow conditions.

2.8.4.9. **Chemical House**

The chemical house along with necessary storage space of 140 sqm plinth area in ground floor shall be provided. The top floor of Chemical house shall contain PACl and

other chemical dosing equipment, PACl dosing tanks, agitators/mixers, piping to the injection point and injection devices, dosing metering pumps and the instrumentation equipments. Arrangement for water supply, drainage and lighting shall be made in the Chemical house for necessary functions to be conducted efficiently.

A weighing machine, for and electrical hoists of minimum 500 Kg capacity shall be provided. At least two trolley of 250 kg capacity and one platform weighing machine of 1000 kg shall be provided. Suitable arrangement for unloading of chemicals shall also be made in the chemical house.

The minimum plinth areas as detailed hereafter shall be provided in the administrative and chemical building.

2.8.4.10. **Chlorine Room, Chlorination and Chlorine Storage**

All safety by-laws for chlorine handling and storage shall be followed. The Chlorine Building & Storage Yard shall be constructed for providing pre & post chlorination to raw water inflow of 23.71MLD (minimum output capacity to be 23.47 MLD in 22 working hours). 8 full 900 kg chlorine toners shall be supplied.

The chlorine control building shall be provided in the ground floor of Administrative block.

The Chlorine Building & Storage Yard shall have Chlorine sensors and audio alarms for detection of abnormal level of chlorine in ambient air. The chlorine sensors shall also be connected to the PLC system of treatment plant for initiating necessary safety measurers.

The chlorine cylinders in chlorine storage yard shall be installed in an enclosure with a top hood which can be completely opened for placing / removing the cylinders. The chlorine yard should be connected to internal campus roads to enable direct loading unloading from trucks. For loading / unloading a 2 MT electrical hoist shall be provided.

In case of excess chorine in ambient air within the chlorine storage yard, the area must be equipped with all required safety equipments for safe operation such as, start of exhaust fans connected to a chlorine scrubber with sprinkling system of NaOH solution and water to neutralize the leaking chlorine gas. The neutralizing system should be designed to neutralize 900 Kg chlorine in 4.5 hours.

Minimum two vacuum chlorinators (one working + one standby) of rating 5 Kg/Hr. for pre-chlorination and two vacuum / gravity feed chlorinators (as per hydraulic requirement of system) (one working + one standby) of rating 3 Kg/Hr for post-chlorination of filtered water shall be provided. The rating, data sheet and GFC drawings of Chlorinators are to approved by EiC.

All chlorinators installed shall have facilities for metering the dosing rate of chlorine and valves for modulating the flow. Only the valves on the manifold of the chlorine tonners should be auto operable with controls from PLC system.

The chlorinators shall be equipped with all other mechanical and all other appliances including chlorinators, valves, pipe work, injectors, distributors, accessories and fitting for chlorine handling and dozing, etc.

All pipelines including connections to wash water tank, water pipe work for chlorinators and interconnecting pipe work including making connections, tapping where necessary, procurement of all materials, fabrication of pipes, bends, tapers, etc. flanges, manholes, fittings, valves, flushing connections, washouts, flexible couplings, dismantling/ expansion joints, linking, finishes, pipe protection, supports, anchorage shall be part of scope of work.

2.8.4.11. **Outlet Channel**

In the outlet channel, one pH, One Turbidity and one residual Chlorine sensor shall be provided. The output of these shall be feed to the Instrumentation control panel / PLC system.

2.8.4.12. **Chlorination Chamber/ Chlorine Contact Tank**

For post chlorination, a chlorination chamber shall be provided before the clear water reservoir. The chamber shall have minimum 10 min contact time to ensure a complete diffusion of the chlorine solution before it leaves the chamber.The minimum capacity of the tank shall be of 180 KL. There shall be no smell of chlorine at a distance of 10 m away from the chamber. The minimum freeboard shall be 30 cm. Chlorine diffuser, baffles for diffusing chlorine solution, and lining for protection from corrosion shall also be provided.

2.8.4.13. **Outdoor Piping**

Outdoor piping works including piping for filter backwash, Tube Settlers/ clariflocculators drainage system and their interconnectivity shall be in the scope of work to achieve the objectives of minimum losses and maintaining dry and healthy status of the treatment plant campus.

2.8.4.14. **Recycling system**

For recycling of the waste water from the drainage system, the drainage line from the filter area (wash water gallery & Tube Settler/ clarifier) shall be taken to a sludge Buffer Tank for 6 hour detention period. The homogenized sludge from buffer tank shall be pumped to sludge thickener. The settled waste water from this sludge thickener shall be decanted to an adjoining tank from which it shall be pumped to the inlet chamber. 100% standby pumps shall be installed. Decanted water shall be re-cycled to filter plant after ascertaining that turbidity of water is not more than 500 NTU.

The underflow sludge from this shall be sent to centrifuge or volute type screw press for producing sludge cake of 20-30% consistency. This sludge is to be dumped by contractor to sludge dump site to be prepared under the contract at designated site by department. The contractor is to develop the land fill site for sludge dumping and protection for Aluminum leaching.

The sludge from the settling tank shall be pumped to sludge handling system. All related electrical & mechanical components and piping arrangements are included in this scope of work. The minimum total live capacity of recycling tanks shall be 460 KL. Its shape will be rectangular with 30cm freeboard & 25cm sludge deposition depth apart from live capacity. It will be open to sky.

2.8.4.15. **Administration & Control Building**

1. Administration and control Building shall be provided under the scope. Administration & Control Building shall be constructed for the requirement of various

units/operation for design in flow of 23.71 MLD(minimum output capacity to be 23.47 MLD in 22 working hours).
2. Low Voltage control panels for lighting distribution, operation of actuator motors, shall be provided in motor control center in a separate room. The back wash pumps shall be housed near the clear water channel in ground floor with positive suction pumps and the air blower shall be placed on the first floor.
3. Providing toilets one each in Chemical House at ground floor and Administrative building on first floor.
4. The minimum plinth areas as detailed hereafter shall be provided in the administrative and chemical building.

2.8.4.16. **Building Planning and Areas in Filter Plant Chemical House and administrative Building**

It is envisaged that the filter plant to be constructed shall provide very good aesthetic look and shall be very well architecturally planned.

The plant layout in general shall consist of the central section of filter beds with clear water channel in front. The central section shall have a lobby of minimum 1.5 m width in addition to the width of clear water channel. The top of the clear water channel shall be 0.05 to 0.10 meters above the lobby in front of the clear water channel. The lobby shall be of at least 2/3rd length of the filter beds. The pipe gallery shall be open and ladders shall be provided for access to valves. The pipe gallery shall be sufficient wide for opening the flange bolts of pipes and valves. The operating gallery of the filters shall be provided above the pipe gallery with access through a RCC stairs from administrative block side and an aluminum ladder from other side. The filter control console shall be provided in the operating gallery.

The columns and wall sections of the front wall of the lobby shall be provided with stone butch or shall be of coursed rubber masonry of approved stones. The back wall (facing filters) shall be of brick masonry or of stone masonry, with plaster in CM 1:6 on both faces. The front wall of the lobby shall be of full glass paneled with tinted glass, except in the center panel housing the door, in a grid fashion as per architectural planning. The back wall shall contain aluminum long windows as per architectural drawings above the level of clear water channel.

The roof of this section shall be at sill level of the first floor. Roof shall be designed to provide a good elevation.

The Administrative and chemical block shall be provided on either sides of the filter beds. The blocks shall in general be of identical widths in front elevation. The front walls of the two blocks shall be provided with stone butch or shall be of coursed rubber masonry of approved stones. All windows of the plant and the Administrative and Chemical block shall Aluminum section glass paneled windows of approved shape and sections. The administrative and chemical blocks shall be projected in front of the front wall of the central lobby to provide a "C" shape look to the building. Entry to chemical and

administrative blocks shall be from the lobby. Additional entry, as per requirement shall also be provided from side walls or back walls for Chlorination room, LT control panel room, chemical store and toilets. The general arrangement of building shall be in such a way that for future WTP no building work is required.

The minimum plinth areas required for the various units in building are as follows:

Chemical store for PACl and allied chemicals – Ground Floor	50 Sqm
Pump Room for Backwash pumps– Ground Floor	15 sqm
Blower Room on first floor– First Floor	15 sqm
PMCC room –– Ground Floor	20 sqm
Control Room – First Floor	30 sqm
Laboratory	15 sqm
Chlorination Room	30 sqm
Office area (AEN office, Tech. Staff area,	150 sqm

Adm staff area, Conference room, Lobbies etc)

In the building minimum three toilet block each not less than 4 sqm area shall be provided. One in chemical block in ground floor and one each in ground and first floor of administrative block. RCC stairs shall be provided with minimum 1.2 m wide steps in administrative and chemical blocks for access up to first floor. Aluminum ladders shall be provided for access to roofs of central lobby; chemical block and administrative block. Suitable logical partitions shall be provided in the office area, as per approval of Engineer in Charge.

The height of Ground level block shall be 4.0 meters and that of first floor 3.5 meters.

The minimum capacity of wash water tank shall be 230 KL.

2.8.4.17. **Civil Works related to WTP**

The civil works shall comprise the design, supply, construction and testing of all associated civil works which shall include but not be limited to:

1. Repair of existing 500 m long approach road up to existing GLSRs and extension of existing approach road up to WTP for a minimum distance of 140 m or as per directions of engineer in charge. The work includes clearance of existing road and area around it. Construction of internal campus roads and pathways at Machla Magra WTP campus as per the specifications.
2. Retaining wall along the periphery of Water Treatment Plant and its components including repair of existing boundary wall of existing High Zone GLSR as per directions of engineer in charge and providing RCC cover for valve camber for passage of vehicles.

3. Providing LED lights along the approach road to Machla Magra WTP at a maximum distance of 30 m and as per specifications and directions of EiC.
4. All associated structures and buildings for treatment works process units and ancillary works including access into and between structures:
5. Building services including domestic water, soil and waste systems including pipe work of any size and description and all materials with all necessary fittings, specials, valves, storage tanks, sinks, sanitary fixtures and appliances, plumbing and the like.
6. Valve chamber/s associated with pipelines, guniting, concrete surrounds for pipelines for water supply, storm water drains, sewers, waste water system and allied works.
7. Inspection chambers, manholes, station pipe work and all accessories necessary for reception collection and conveyance of all flushing drainage, overflow and waste waters as required. All items required for treatment and disposal of sludge and treatment of filter back wash water. The sludge waste and overflow from various units shall be connected to the nearby drain. Arrangements for disposal of bypass water and works overflow shall also be made. Adequate Storm water drains; septic tank, soak pit and sewers with appurtenances should be provided for disposal of waste in the entire campus.

2.8.4.18. **Other Civil Works**

The following items form the part of ancillary civil works to be provided under the scope of water treatment plant.

(i) Parking in full breadth in minimum 5 m width.
(ii) Site & horticulture development and general site fill etc.
(iii) Providing drinking water facilities, a water cooler of 40/80 liters capacity
(iv) Providing rain water harvesting arrangement to transfer rain water from pump house buildings. A RCC chamber of minimum 5x5x2.5m size shall be constructed with vertical filter to arrest suspended particles followed by another chamber of 4x3x2.5m size in which a bore of 200mm dia and 50mt depth shall be constructed to transfer decanted water in the ground with necessary inlet, outlet. overflow & washout arrangement.

2.8.4.19. **Water Sampling System Installation**

Providing valves/ taps, pipe work, water quality monitoring instrumentation and all accessories, required for sampling at inlet & outlet channel.

2.8.4.20. **Use of Chemicals**

Under the contract all chemicals including liquid chlorine for pre-chlorination & post chlorination, Alum, Lime etc. required to treat raw water shall be acquired by the contractor and used to achieve the required quality. The quantity of chemicals to be used will be assessed by the contractor on the basis of quality of raw water which varies from month to month. The decision of EiC shall be final with regards to use of chemicals. Record shall be maintained by the contractor for use of chemicals.

2.8.5. **Power System**

0.44 Kv power transmission main shall be taken from 11/0.44 Kv substation being installed for to WTP and CWPS through XLPE cables. The output from the transformers shall be taken to the LT control switchgear in treatment plant from where the different feeders for electrical equipments shall be connected through bus bar arrangement in LT control panel. LT control panel will be provided with all necessary equipments to control & operate electrical machineries installed in WTP and pumps, valves and instrumentation installed at Machla Magra CWPS.

2.8.6. **Laboratory Equipments**

Following minimum laboratory instruments/equipments shall be provided but shall not be limited to:

S.No.	Name of Instrument	Qty.
	pH Meter	2
	Turbidity Meter	2
	Chlorine Comparator	6
	Conductivity meter	1
	B.O.D Incubator	1
	Dissolved Oxygen Meter	1
	300 liter capacity Refrigerator	1
	Pipettes, burettes and other glass ware	As per requirement
	Incubator	1
	Autoclave	1
	Water Bath (serological)	1
	Colony counter	1
	Membrane Filtration Assembly	1
	Binocular Microscope	1
	Electronic Balance	1
	Jar test apparatus	1

S.No.	Name of Instrument	Qty.
	Magnetic Stirrer	1
	Distilled Water Plant	1
	Sampling Bottles (Reagent Bottles of 250 ml Capacity)	24
	Electric Oven	1
	Centrifuge	1
	Wire Baskets	6
	Suction Flask (1litre capacity)	2
	All types of laboratory glassware, accessories and other consumables and reagents for minimum one-year requirement.	One Lot

2.8.7. Instrumentation Systems At Treatment Plant

2.8.7.1. General

It is proposed to have full safe operation of the filter plant to meet the varied demand of water in most efficient manner. The scope of work would cover conceptualization, design, pre-dispatch inspections, supply, installation, and pre-commissioning test, commissioning tests, commissioning and trial run of the entire Instrumentation system. The detailed specifications of the equipment proposed to be installed shall be submitted for necessary approval of the Department.

The instrumentation system shall be able to achieve the objectives listed below.

2.8.7.2. Requirement of the Instrumentation System

The entire Instrumentation system is required to receive & store the information From Electrical, Mechanical & Instrumentation Equipments.

2.8.7.2.1. Electrical System:

a. Input voltage and amperage of 440 V system and all motors of compressor/blower and back wash pumps, pumps at sludge buffer tank.
b. Input voltage and amperage of 440 V system and all motors of pumps and valve actuators installed at CWPS Machla Magra.
c. Status of flash mixer; flocculator and bridge drive motors
d. Status of chemical mixing motors on PACL tank

e. Status of exhaust fan in hood of chlorine yard

2.8.7.2.2. **Mechanical Equipments**

i) Status of all dewatering pumps, backwash pumps, blowers, sludge pumps etc.

ii) Status (Open / Close / Local / Remote) of motorized valves and gates in inlet system (inlet valve & gates to flash mixer), sludge bleeding valve of Tube Settlers/ Clariflocculators, inlet gates/valves to filter bed, wash water gates to filter beds, outlet valves of beds, air inlet and wash water inlet valves, valves on air and back wash header pipes, suction and delivery valves of back wash pumps and blowers, delivery valves of pumps installed at CWPS Machla Magra etc.

iii) Status of chemical feeder valves and chlorine manifold valves.

iv) Status of dose-metering pumps

v) Status of control valves on chlorine scrubber system

vi) Status of pumps (On/ off/ Manual/ Trip) installed at CWPS Machla Magra.

2.8.7.2.3. **Instrumentation Equipment**

Flow data (instantaneous flow rates and total flow) from the, inlet channel of filter plant & back wash water main in filter plant,

I. Raw and treated water parameters such as pH, turbidity,

II. Residual Chlorine in clear water

III. Chlorine in ambient air in Chlorination room and chlorine yard

IV. Energy meters and multifunction meter at CWPS Machla Magra.

V. Flow at inlet of Cascade Aerator and at common delivery of pumps at Machla Magra.

VI. Flow at inlet of new proposed GLSR, existing High Zone and Low Zone GLSR.

VII. Level of water at Clear water sump, Proposed 5.1 ML GLSR, existing High Zone and Low Zone GLSR.

2.8.7.2.4. **Alarm Situations**

The alarm schedule is indicative of what is required. The Contractor shall provide for the annunciation of all alarms necessary in order to achieve control and monitoring requirements.

1. Pumps
a. Motor tripped on over-load.
b. Pumps failed to start/stop.
2. Filter Plant
a. Levels of water in CWR abnormally high.
b. Abnormally low differential head across filter beds.
c. Abnormal high level of chlorine in ambient air at chlorination room and in chlorine storage yard.

2.8.7.3. **Requirements of PLC and SCADA system**

Each Instrumentation system shall be supplied with required:

1)PLC : CPU, Memory, Rack, Power Supply, Communication Module etc

2) Signal Conditioners, Interrogation Power Supplies, Interposing Relays etc.

3) Input/Output Modules

4) Data communication bus

5) Instrumentation control panel

6) The man machine interface (MMI) consisting of

- One Personal Computer with 17" colour monitor of approved make.
- A3 sized colour Laser Printer of approved make.
- Keyboard and Mouse Control of approved make.
- Panel Power Supply via an uninterruptible power supply (UPS min 1 KVA) of approved make.

7) Remote I/O Racks

8) Filter Bed Console with MMI and remote I/Os

9) Radio Frequency Interface modules, radios, RF Cables, Antennas, Mast, lightning arrestors etc.

The PLC system shall be developed to enable automatic operations as per the logics required for a standard operation of the filter plant. Adequate safety shall be taken to ensure that the data received are not distorted due to lighting effect etc.

Operation of all motorized valves, motors, pumps and machine should be possible through the PLC system, local bush button station / local console and manually.

The PLC system shall also be linked to a radio communication system setup at the treatment plant unit with connectivity to radio receivers at Intake, WTP-CWPH & Executive Engineer office Udaipur. The radio communications shall have two different channels one for data / command communication and other exclusively for voice communication. The Radio system for Data / Command communication shall be linked to a GSM system through which SCADA operations are possible from any remote site. All hardware and software for such communication and SCADA system shall be within the scope of the contractor. With the radio communication system the contractor shall provide 6 mobile sets with necessary batteries and minimum 3 battery chargers. The radio system shall have range covering the stretch from Intake to Executive Engineer office Udaipur.

Required Instruments

To achieve the objectives listed above in scope of work, the contractor shall provide the required numbers of equipment / sensors. Main equipment required are as listed below. The list is not comprehensive and the scope of contract shall not be limited by the list but shall include all probes, level sensors, input-output modules, interfaces, other sensing elements, cabling, ducting, earthing, providing lightening protection, providing facilities of local display of readings from instruments, etc.,

The main equipment required are as listed below but not limited to:

i. 600 mm diameter Electromagnetic flow meter for inlet pipeto Cascade Aerator with transducer and Digital flow Indicator & flow Integrator – 1 no.
ii. Full bore Electro-Magnetic flow meter with transmitter and Digital flow Indicator & flow Integrator of size not less than 150 mm on the back wash pipe.
iii. Bulk meter with transmitter and Digital flow Indicator & flow Integrator of size not less than 100 mm on the air pipe
iv. Full bore Electro-Magnetic flow meter with transmitter and Digital flow Indicator & flow Integrator of size not less than 100 mm for air header pipe
v. Sensors for transmitting the differential head across the filters to the Instrumentation Control panel, for each filter bed.
vi. Continuous pH meter with transmitter and indicator at inlet and outlet – 2 Nos.
vii. Continuous turbidity (nephelometric) meter with transmitter at inlet & outlet – 2 Nos
viii. Continuous Residual Chlorine sensor at the outlet – 1 No
ix. Chlorine sensors in Chlorine control room and chlorination yard – 2 Nos.
x. Ultrasonic flow meter for inlet pipeto clear water sump from Chlorine contact tank with transducer and Digital flow Indicator & flow Integrator – 1 no.
xi. In addition to above the following portable sensors / equipment (one each) are also to be supplied:
    - pH meter
    - Turbidity meter
xii. Instrumentation at Clear Water Pumping Station

To achieve the objectives listed above in scope of work, the contractor shall provide the required numbers of equipment / sensors. Main equipment required are as listed below. The list is not comprehensive and the scope of contract shall not be limited by the list but shall include all probes, level sensors, input-output modules, interfaces, other sensing elements, cabling, ducting, earthing, providing lightening protection, providing facilities of local display of readings from instruments, etc., which are essentially required for automation through PLC systems in future.

The main equipment required are as listed below but not limited to:

- 400 mm Electromagnetic flow meter with transmitter, Digital flow Indicator & flow Integrator on 400mm common delivery header.

- Pressure sensors, transmitters and indicators at delivery pipes of each pump.- total 2 Nos (on each individual delivery).
- Energy meters for each pumps installed at CWPS Machla Magra with transmitter and Digital energy Indicator - 2 nos.
- Multifunction meter to be installed at incomer of LT panel with transmitter and Digital Indicator - 2 nos.

2.8.8. **Furniture to be provided**

S. No.	**ITEM**	**Nos. Required**
	Wooden Executive Table 6x4x2.5 with sun mica top & cupboard/ drawers	1
	Steel Table with SMT 4x2.5x2.5 (for Site Engineer, Accountants and Head Clerk)	3
	Revolving Chair with cushioned seat & back	1
	Visitor Chair	6
	Ordinary cane chair- (for all other staff and visitors)	6
	Steel Almirah 1980mm x 915mm x 485mm	2
	Filling cabinet	1
	Steel Almirah 1270mm x 765mm x 440mm with glass paneled doors	2
	Racks – 5 Tier 1800mm x 900mm x 375mm	2
	Air Coolers	3
	Latest configuration computers with 17" color monitor, 1 KVA UPS, One A-4 size B/W Laser printer, one A-3 size color inkjet printer, multimedia kit, minimum required software's etc.(In addition to computer required for WTP, to be supplied immediately after award of contract). 6 No additional ink cartridges shall be supplied with printers.	2 Sets
	Automatic Power inverter with batteries & required wiring suitable for load of 4 KW. To be installed in Executive Engineer Office at Jhalawar.	1

S. No.	ITEM	Nos. Required
	Xerox machine To be installed in Executive Engineer Office at Udaipur. Canon/ RICOH/ Godrej/ Samsung make. With 6no additional ink cartridges (to be supplied immediately after award of contract).	1
	Computer tables designed for space for UPS, CPU, Monitor, Keyboard and printer etc.	3
	Computer revolving chairs with cushioned seat & back	3

2.8.9. Clear Water Reservoir (CWR)/ CLEAR WATER SUMP at treatment plant

The clear water channel from chlorine contact tank of the treatment plant shall be connected to the inlet chamber(s) of the CWR's/ Clear Water Sump to be constructed under this contract. A clear water reservoir of 240 KL live storage is to be constructed near the treatment plant within the treatment plant campus.

The CWR/ Clear Water Sump roof must be kept at least 0.60 meters above general ground level. Suitable ventilation shall be provided in the CWR/ Clear Water Sump roof at appropriate location and all opening of CWR/ Clear Water Sump shall be kept covered and lockable. The ventilators shall be provided with MS grill and stainless steel wire gauge net, to prevent dust entering CWR/ Clear Water Sump. **The minimum TWL (Top Water Level) of Clear Water Sump/CWR must be 629.7 m so that High Zone and Low Zone GLSRs can be filled by Gravity flow.**

At least one aluminum ladder in addition to RCC stairs shall be provided for access to CWR/ Clear Water Sump floor.

The CWR/ Clear Water Sump shall be provided with a sump level indicator of capacitance type and also with a float operated level indicator with gauge standing along the vertical wall. A wash out of 300 mm and an overflow of 500 mm shall be provided. The wash water pipe and the overflow pipe shall be taken up to a chamber through which it shall be connected to the campus drainage leading out of boundary at a distance about 200m or as per site given by engineer in charge.

The major components of this work as above concept shall be as following but shall not be limited to:

The works detailed below includes providing and installation of material unless otherwise mentioned. MS pipes used for the works detailed below shall have minimum 6.3 mm thickness and shall be internally and externally coated as per specifications.

i. Construction of 240 KL live storage RCC clear water reservoir
ii. Providing interconnection with clear water channel of treatment plant.

iii. Providing puddle collar, 90 degree bend/ duck foot bend, flanged CI pipes connecting bend and duck foot bend, pipe connecting duck foot bend and the collecting chamber suitably placed in campus.
iv. Providing 400 mm puddle collar at the bottom of the reservoir in a sump of reservoir for outlet. Connection of the outlet puddle flange to suction pipe of clear water pumps with one sluice valve & dismantling joint.
v. Ultrasonic type Sump level indicator with transmitter and Digital Indicator at Intake sump– 1 No.
vi. Interconnection of Clear water sump to existing high zone and low zone GLSR through gravity flow pipeline.

All instrumentation system installed shall have communication to the control room situated in the treatment plant building.

2.8.10. **CLEAR WATER PUMPING STATION**

Two number of centrifugalpumps (one working + one standby) eachcapable to discharge 191.11 LPS(15135.91 KLD in 22 hours) quantity of water at 24 m head shall be provided under this contract. For pumping clear water to proposed 5.1 ML GLSR to be constructed under this contract.

The pumping station at Machla Magra is to be planned to be installed on Clear water sump at the outlet of Machla Magra WTP. Pumps are to be installed in open over the roof of clear water sump.The scope of work includes commissioning of pumping system with providing & installation of two pumps withdelivery, manifold, pipe appurtenances, specials, power system & allied civil, mechanical & electrical works is under the scope of this contract. The pumping plant &machinerywith associated power system includes design, manufacturer& testing at manufacturers works, packing for shipment, delivery to site, supply, unloading, storing, complete erection, setting to work, installing, pre-commissioning, trial runs, commissioning, rectification of defects for a period of one year from date of successful commissioning of all related mechanical, electrical & instrumentation equipment's.

The pump house at Machla Magra shall have2 centrifugal pumps with positive suction head. Theminimum C/C distance between pumps to be installed under this scope shall be kept as 2.5m.

The suction pipe for the individual suction is to be provided.

For pumps, outdoor type electric consoles are to be installed at clear water sump and common LT panels for WTP and CWPS are to be installed.

2.8.10.1. **Civil works**

The proposed pumping station is to be built near WTP at Machla Magra. The pumping station shall have necessary motor floor for installation of 2Submersible/ centrifugal pumps.

The civil work envisaged shall be as following but not limited to:

The pump house area shall include:

1. Two pumps each suitable to deliver 191.11lps water will only be installed.
2. Construction of control room for system within the WTP Machla Magra.

Provide & install suction manifold MS (6.3mm thick) pipe to provide required positive suction headin the pump house. The suction pipeline shall be laiddirectly inside clear water sump.

(ii) Providing cable trays within the pump house building for installation of motors & other electrical and instrumentation equipments.

(iii) Providing delivery manifold pipes for transmission mains in the pump house with thrust blocks & supports for laying & jointing of delivery manifold pipes under this contract.

(iv) Providing & installations of all safety equipments (fire & electrical shocks).

(v) Providing facility for potable water supply with water cooler of 40 ltr capacity.

(vi) Providing pipe supports & thrust blocks/ anchor for delivery pipes, valves & manifold pipes, meter chambers as per scope defined in this contract.

(vii) Providing 1 no fire extinguishers at following locations

(a) GSS area. (b) Indoor electrical room (c) Pump room maintenance bay

(d) Control room.

(viii) Providing first-aid kit.

The contractor shall provide his own design/arrangements of pumpsconsidering overall economy and ease of operation during O&M period. The responsibility of correctness, effective operation of the system shall rest on the contractor. However, the design and planning of the pump house and the associated structures shall fulfill the following minimum requirements:

2.8.10.2. **Design, Supply, Installing, Testing, Commissioning**

The pumping plant and machinery with the associated power system includes, design, manufacturing, Testing at manufacturer's Works, packing for shipment, delivery to the Site, Supply, unloading, storing, complete erection, setting to work, Installing, Pre-commissioning, trial run, commissioning and operation and maintenance for 10 years. The works component included are as defined below but shall not be limited to:

2.8.10.2.1. **Mechanical Equipment**

The works component included are as defined below but shall not be limited to:

I. Minimum 2 Nos. of submersible low life cycle cost type/ conventional vertical turbine pumps (1 working, 1 stand by) of similar characteristics with all the accessories.
II. 400mm suction pipes for two pumps under this contract.

III. 400 mm discharge pipes, along with necessary supports for pumps to be installed in this contract.
IV. Eachdischarge pipe shall have manually operated Sluice Valve, electrically operated Butterfly valve, dual plate check valve, kinetic air valve and two dismantling joints of pipe size.
V. The manifold of MS pipe 400mm dia. with minimum thickness of 6.3 mm for providing connectivity for pumps will be provided. All pipes in the pump house shall be internally & externally painted with non-toxic epoxy.
VI. Surge protection device as per design.

2.8.10.2.2. **Major Works**

0.44KV supplies shall be made available from transformer to incomer bus bar of pumping station through XLPE cables to the respective panels.

The works component related to electrical installations in pump house included are as defined below but shall not be limited to:

1. Providing, installation, testing and commissioning of suitable 0.433kV LT motors for the pumps of adequate rating. Operation of 0.433 KV motors shall be possible through LT panel, local push button andPLC system.
2. Providing solid state electronic soft starters for 0.433 kV motors.
3. Providing microprocessor based motor protection relay in each 0.433 kV motor feeders with HRC fuse and vacuum contractors.
4. ***Operation of all LV motors shall be possible through LV panel, local push button and PLC system.***
5. Providing indoor 0.433 kV switchyard control panel.
6. Providing and installation of0.433 kV switchgear with motor control panels for individual motors.
7. Providing and installation of 0.433 kV capacitor banks including APFC relay(s) with capacitor panels.
8. Providing and installation of LT switchgear control panel.
9. Panel for operation of motor operated butterfly valves with all other LV panels and distribution board.
10. Providing Exhaust fans for proper ventilation and maintenance of desired temperatures within the pump/motor room and MCC room.
11. Providing metersand protection systems with necessary equipments/accessories.
12. Local push button stations near all motors and valve actuators.
13. Cabling and ducting for entire electrical system.
14. Earthing and lightning protection system at all relevant points.
15. Any item not included above but required as per standards shall also form the part of scope.

2.8.10.2.3. **Instrumentation Systems At Pumping Station**

2.8.10.2.4. **General**

It is proposed to have full safe operation of the pumping station to meet the demand of water in most efficient manner. The scope of work would cover conceptualization, design, pre-dispatch inspections, supply, installation, pre-commissioning test, commissioning tests, commissioning, trial run and maintenance of the entire Instrumentation system for 10 years.

The detailed specifications of the equipment proposed to be installed shall be submitted for necessary approval of the Department. The configuration of the system shall adhere to the principles detailed in the respective Chapter of "Specifications for Instrumentation".

Irrespective of the detailed specifications of the respective items detailed in the chapters of pumping stations and filter plant, the contractor shall be required to provide all equipment, accessories, cabling, earthing, providing necessary transducers/sensors, etc. A PLC system shall be deployed for complete automation. To integrate the future PLC/ SCADA system with the instrumentation work in this contract, the bidder shall provide all electrical and instrumentation systems which can be linked with the future PLC system. The instrumentation system shall be able to achieve the objectives listed below.

2.8.10.2.5. **The Instrumentation System**

The entire Instrumentation system is required to receive & store the information From Electrical, Mechanical & Instrumentation Equipments

1. **Electrical System:**

I. Input voltage and Amperage of 11 kV, and input voltage and Amperes of 0.433 kV system, individual motors & auxiliary transformers.
II. Power consumption (kWH) and power factor on 11 kV system, 0.433 kV system, auxiliary transformers and all LT motors
III. Status of all LT motors (on/off)/ & all parameters.

2. **Mechanical Equipments**

I. Status of all pumps.
II. Status (on/off/) of Butterfly, on individual pumps delivery.

3. **Instrumentation Equipments**

I. Flow data (instantaneous flow rates and total flow) from the pumping station through 400mm electromagnetic flow meter installed on 400 mm common delivery header.
II. Pressures sensors and transmitters at delivery of each pump & manifold.

2.8.10.2.6. **Alarm Situations**

The alarm schedule is indicative of what is required. The Contractor shall provide for the annunciation of all alarms necessary in order to achieve control and monitoring requirements.

(i) 11 kV power failure

(ii) Motor tripped on over-load.

2.8.10.2.7. **Requirements of Instrumentation system**

Each Instrumentation system shall be supplied with:

(i) Input/Output Modules

(ii) Instrument Control Panel (I.C.P.) / Control Desk with MMI panel

2.9. **Rehabilitation/Rejuvenation works.**

1 Contractor shall arrange the all material, labour and scaffolding etc. for rehabilitation work and cost of these shall be included in lump sum cost of work.

2 Where ever the repair work in R.C.C in structures like P.H. building etc the following processes are to be taken :

Removal of defective concrete, clean the surface thoroughly and clean the rusted reinforcement with rust remover chemical. Rubbing the bar with wire brush and clean the bar with water, applying the shotcrete mixture mechanically with compressed air under pressure, comprising of cement, sand, coarse aggregates, water and quick setting compound in the proportion as per clause 2807.1., sand and coarse aggregates conforming to IS: 383 and table 1 of IS: 9012 respectively, water cement ratio ranging from 0.35 to 0.50, density of gunite not less than 2000 kg/cum, strength not less than 25 Mpa and workmanship conforming to clause 2807.6. complete as per clause 2807 of MoRT&H specification.

2 Dismantling material to be disposal off with in lead of 250 m as per the direction of engineer in-charge.

3 Contractor shall visit the work of rehabilitation at site and assist the work before tendering.

The details of rehabilitation works to be done are as below:

2.10. **Civil Works & Building Works**

2.10.1. **Master Control Center& Consumer Care Centre**

The Scope of work includes construction of Master Control Centre& consumer care centre at Udaipur City.

- The master control center shall be a two storey building with minimum plinth area of 100 sq.m. at each storey. It will have adequate capacity for establishment of Master control Center for IMIS Vendor as well as seating facility for Departments Staff or water quality testing laboratory and consumer utility facility. The Hardware & Software are not in scope of work of this contract and shall be provided & installed by IMIS Vendor.The Control centre shall house the control centre for infrastructure created under this project. The control room building shall be

suitable to accommodate the Master Control Centre equipment and seating capacity for department staff.

- The consumer care centreshall have adequate area (minimum plinth area of 100 sq.m.) to accommodate the consumer visiting facility, water quality testing laboratory and seating arrangement of office staff.

2.10.1.1. **Civil Works**

The civil works envisaged shall be as following, but not limited to:

The Structure shall be RCC Framed structure.

The works shall comprise the following but not be limited to:

- Trenches for pipes and cables
- All windows, doors, rain water pipes,
- Drainage arrangements
- Site works, pathways and landscaping.
- Battery room
- Water Supply arrangement i.e. Storage Tanks, pipes etc
- Wastewater arrangement such as toilets, pipes, septic tank etc
- Building Electrification

The size of the master control centre shall be got approved by EIC in view of housing all other equipments / facilities narrated above.

The minimum specification for various building elements shall be as follows or as per approved drawing by Engineer-in-Charge

S. No.	Description of Components	Specifications
1	Base concrete for foundation M20	30cm thick
2	Masonry in foundation and plinth	RCC framed structure
3	Damp proof course	M25 R.C.C., minimum 75mm Thick
4	Superstructure Brick Masonry in	CM 1:4, 23cm thick
5	Lintels sun-shades etc.	R.C.C. lintels & sun shades as per approved drawing.
6	Roofing	R.C.C. Roofing as per approve drawing with water proofing admixtures approved by Engg.-in-Charge.

S. No.	Description of Components	Specifications
	Roof Treatment	Lime Dhar
7	Interior Finish (Cement Plaster)	20mm in cement plaster 1:6.
8	Exterior Finish	25 mm Cement plaster 1:4 / Cement Sand plaster as per approved drawing
9	Flooring	
a	With CC M10 base	Soling Stone with C.C. M10 base concrete
b	Finish	Kota Stone
10	Skirting and dados	10 cm. Height of same material for floors & glazed ceramic tiles for toilets upto lintel level
11	Windows (frame, panels, wire-gauging safety bars)	Steel Section window as per drawing
12	Doors (Frames and shutter)	**Frame** - pressed steel section **Shutters** - Flush door 38 mm
13	White/ Colour/Cement lime/ Decorative Finish	Acrylic emulsion paint
14	Painting of doors Windows and walls	Synthetic enamel paint on steel members and spirit polish on wooden members
15	Electrification (type of wiring, fittings and fixture)	PVC Conduit wiring as per approved drawing and specifications. 16 A ampere switches shall be provided as per requirements in all room and Meter board with MCBs kit-kat fuses and electric meter earthing protection system shall be installed for each unit.
16	Sanitary & Water Supply	
(i)	Indian WC	In common toilets
(ii)	European WC	In attach toilets with room
(iii)	Wash Basins	In every toilets and in lounge
(iv)	Sinks	Stainless Steel sink
(v)	Other accessories	As per approved drawings
17	Other Specification	PVC frames & shutters in Bath rooms/Toilets
18	**Special fitting and fixture**	
a	Fans	In every Room
b	Tube light	In every Room
c	Exhaust fans	Bathroom

2.10.1.2. **Electrical Works**

- Provision of LV switchboard in Master Control Centre building to receive the incoming electricity supply cables and distribute accordingly.
- Provision of all necessary building services installation works for the Master Control Centre building, including earthing and lightning protection systems.

2.10.2. **Furniture &Other Items**

The scope of work includes providing & installation of following items of furniture at ABD Area Udaipur city;

S. No	Item	P.H (2 Nos)	Consumer Care Center	Office	WTP	Total Nos
1	Steel almirah 78*36*19 Full size with four shelves Making five compartments Made in 20/22 g weight approx 72 Kg.	2	1	2		5
2	Steel almirah 50*30*17 Small size with two shelves Making three compartments weight approx 50 Kg 20/22 g.	2	1	2		5
3	Executive high back chair Metal frame with fully thick Cushioned Rexine fabric with cushioned arms Gaslift CR arms wheels Tilting mechanism.	0	1	1		2
4	Visitor chair without arms Flat pipe frame.	0	0	0		0
5	Visitor chair with arms pu.	4	6	7		17
6	Visitor chair with chrome arms.	0	0	0		0
7	Visitor chair with rexine fabric.	2	2	4		8
8	Steel multiseater having Three seater with either side Arms chrome finish heavy Weight approx 36 Kg.	0	2	0		2
9	Steel filling Cabinate Having four drawers Centralised locking 22/20 g sheet 50 kg.	0	2	2		4

S. No	Item	P.H (2 Nos)	Consumer Care Center	Office	WTP	Total Nos
10	Steel office table 5*3*30" having one side three drawers and Cabinate At the side with lock and key pipe 18 g paint finish.	0	1	1		2
11	Steel office table having one side three drawer of size 4*2*30 wooden top duly polished.	2	2	4		8
12	Wood counter 2.5 m long 0.75 depth and 1.2 m height with working top and one drawer complete with superior lemination sheet.	0	1	0		1
13	Cooler size 18" x900 RPM fitted with Marathon (Alstom) Exhaust Fan & water lifting pump fitted in body size 27x27x36" made of 20/22 gauge G.P. Sheet duly fitted. Two separate switches for fan and pump and attractive grill having 6 different direction with duly spray painted.	2	3	3		8
14	Water Cooler Fornt Panel Stain Less Steel Back And Side Panel, 20 Gage Iron Body. 20/20.		1	1		2

2.10.3. **Biometric Fingerprint time & Attendance System**

Biometric finger print time and attendance system of approved quality and make are to be provided and installed at PHED administrative office and all the 7 Sub-division offices and City Division IInd office along with maintenance.

2.10.4. **Security System**

4 CCTV camera units along with 40" LED screen monitor conneted for live feed from CCTV cameras along with storage capacity for 1 week of recordings are to be installed

both at Machla Magra WTP Campus and Dudh Talai RWPS each along with operation and maintenance.

2.10.5. **Any Other Items**

All other items, accessories, work not specified but essentially required to complete of the work on turn key basis.

2.10.6. **Rehabilitation/Rejuvenation works.**

1 Contractor shall arrange the all material, labour and scaffolding etc. for rehabilitation work and cost of these shall be included in lump sum cost of work.

2 Where ever the repair work in R.C.C in structures like P.H. building etc the following processes are to be taken :

Removal of defective concrete, clean the surface thoroughly and clean the rusted reinforcement with rust remover chemical. Rubbing the bar with wire brush and clean the bar with water, applying the shotcrete mixture mechanically with compressed air under pressure, comprising of cement, sand, coarse aggregates, water and quick setting compound in the proportion as per clause 2807.1., sand and coarse aggregates conforming to IS: 383 and table 1 of IS: 9012 respectively, water cement ratio ranging from 0.35 to 0.50, density of gunite not less than 2000 kg/cum, strength not less than 25 Mpa and workmanship conforming to clause 2807.6. complete as per clause 2807 of MoRT&H specification.

4 Dismantling material to be disposal off with in lead of 250 m as per the direction of engineer in-charge.

5 Contractor shall visit the work of rehabilitation at site and assist the work before tendering.

The details of rehabilitation works to be done are as below:

2.10.6.1. **Dudh Talai RWPS**

Existing System:

Pichhola Lake is a major tourist attraction of Udaipur city. Every year lakhs of tourists visit Pichhola Lake to view the serene surroundings and historical monuments on the banks of the lake. The RWPS at Dudh Talai also lies on the bank of the lake. It was constructed in 1973 to feed water to Dudh Talai WTP. Afterwards, as the demand increased the pump house was extended and new pumps were installed.

The maximum reservoir level of Pichhola Lake Is at RL- 595.69m and least drawl level is at RL- 590.52 m. At present, Dudh Talai Pump house supplies water to 2 nos. WTP at Dudh Talai (2.85 MLD and 13.5 MLD) capacity, 2 nos. WTP at Gulab Bagh (4.54 MLD and 2.27

MLD) and 1 no. WTP at Patel Circle (7.57 MLD). There are total 16 Pumps installed at this RWPS of following capacity:

Details of Existing System of Dudh Talai RWPS

PS	Pump Number	Pump Duty Condition	Pump Configuration	Pump Efficiency	Supplying Water To	Rising Main Details
1.	1	341 m^3/hr @ 62 m	1 W + 2 S	35 %	13.5 MLD Filter Plant (Dudh Talai)	450Ø CI
	2					
	3	675 m^3/hr @ 60 m				
2.	8	141 m^3/hr @ 55 m	1 W + 1 S	42 %	2.85 MLD Filter Plant (Dudh Talai)	300Ø AC
	7					
	9	340 m^3/hr @ 62 m	1 W	45 %	Gulab Bagh WTP	300Ø CI
3.	4	340 m^3/hr @ 62 m	1W + 1 S	40 %	13.5 MLD Filter Plant (Dudh Talai)	300Ø CI
	5	288 m^3/hr @ 62 m				
	6	141 m^3/hr @ 55 m	1 W	40%	2.85 MLD Filter Plant (Dudh Talai)	300Ø AC
4.	10	191 m^3/hr @ 30 m	2 W + 1 S	45 %	7.5 MLD WTP (Patel Circle)	600Ø MS
	11	381 m^3/hr @ 40 m				
	12					
5.	13	220 HP each	1 W + 1 S	NA	13.5 MLD Filter Plant (Dudh Talai)	300Ø CI
	14					
6.	15	250 m^3/hr @ 30 m	1 W + 1 S	50 %	Gulab Bagh WTP	

	16	400 m^3/hr @ 45 m				300Ø CI

These 16 pumps were designed to draw 30.66 MLD water from Pichhola Lake. These pumps are installed in different rooms at different levels. The building is very old and the pumps installed are working at very low efficiency and needs to be replaced to increase capacity of the system. As the pump house lies on major tourist spot of the city, it needs complete rehabilitation/modification from architectural view point. New pumps of higher capacity and efficiency needs to be installed to reduce the number of pumps installed and also reduce the maintenance costs and space consumed by the pumps.

Rehabilitation Works to be Done:

The 16 nos. pumps installed presently at Dudh Talai RWPS are working at very low efficiency. All the pumps are to be dismantled including suction delivery arrangements and valves. Conventional vertical turbine pumps or Submerged Vertical Turbine pumps for supplying raw water to Dudh Talai WTP, Patel Circle WTP and New WTP proposed at Machla Magra. The pumps are to be lowered down directly in the Pichhola Lake so as to draw vortex free water at the level of RL- 590.52 m. for this, the pumps have to be lowered at a horizontal distance of 9.15 (30 feet) from the lake side wall of existing pump house structure of RWPS to get vortex free water.

Pumping Stations of RWPS Dudh Talai draws water from the Pichhola Lake through MS pipe puddles. In pumping station 1, there is a submerged RCC sump extended in the Lake at a distance of 5.8 m (19 feet). There are three pillars on this sumps wall which are used as support for a steel truss structure, installed to support the suction pipes PS 1 in cases when Lake water level is down. The length of this truss structure is 9.15 m (30 feet), as this is the distance from where vortex free water can be drawn for supply. It is proposed to use this RCC structure of sump to construct a steel truss structure to support the above described submerged Vertical Turbine pumps to draw water directly from Pichhola Lake.

Major components of the civil work proposed at RWPS are as below:

a) A cantilever type steel truss structure to be provided to support the VT pumps/ submerged VT pumps and the delivery pipes, valves etc. as per preliminary design, depth of this truss structure is 1 m and supported at RL-596.00 m. There are total 5 trusses in span of 6.4 m to support 6 pumps at a distance of 1.6 m each

C/C. The total length of this truss is 10.66 m (35 feet). The support structure for the truss structure will be the strengthened sump structure till the length of 5.8 m (19 feet). After that there is an overhang of length 4.86 m (16 feet). This overhang supports 6 pumps and their components on delivery side. The pumps are to be submerged at a distance of 3.35 m (11 feet) from the sump structure. A steel channel structure is to be constructed on this overhang as a shelter to the pumps and supporting crane to lift the pumps for maintenance purpose.

b) The height of masonry walls of the existing sump in front of PS 1 shall be raised from level 594.47 m to 596.0 m by RCC wall over it.
c) The space between pump house lake side wall and the sump wall shall be dewatered and filled with mass concrete (1:4:8) along with anchoring members for holding down cantilever truss structure. The height of sump wall will be increased to truss level by RCC structure. Trusses will also be embedded in this mass concrete.
d) Fabricating and hoisting the truss structure to cantilevering minimum 4.87 m beyond the outer face of the sump structure to support the VT pumps at minimum 589.52 m to draw vortex free water up to lake level of 590.52.
e) A rail is to be provided at PS1 floor level from this truss structure to road for carrying pumps/ heavy equipments in trollies for maintenance purpose.
f) The pump pit of existing pumping station 1 of RWPS is 3.4 m below the floor level of the PS at RL of 594.8 m. This level is to be increased by filling the pump pit or by supporting columns. The delivery pipes from the proposed pumps will be passing below the floor level of RWPS. For maintenance purpose, 3 nos.trenches are to be constructed for passing of 3 delivery pipes. The trenches are covered by checkered plates. Inlet gate of PS 1 is to be aligned with the rails provided for carrying heavy equipment.
g) Pumping Station 6 is to be used for as Local Control Center room for housing all the SCADA arrangements and Variable Frequency Drives. The floor level of PS 6 is to be raised 6 inches above road level by laying structural slab at the required level.
h) Pumping Station 2 is to be used as store room.
i) Pumping Station 3 is to be used by department as office room.

j) Toilets and Bathrooms are to be constructed in Pumping Station 4 for which soakge pits and necessary arrangements for waste disposal are to be constructed in Pumping Station 5.

Gratings are to be provided above trusses beyond sump structure for free movement of staff at floor level of PS1.

1. Suction and Delivery Sides:
   a. There is no suction side in Submersible Vertical Turbine Pumps.
   b. Delivery side consists of Riser pipe and Delivery Pipe:

There is individual riser pipes for each pump. The details of riser and delivery pipes are as follows:

i. The diameter of riser pipe is 300 mm for pumps for Machla Magra WTP and Dudh Talai WTP and 200 mm for pumps for Patel Circle WTP.
ii. The diameter of delivery pipe 400 mm for pumps for Machla Magra WTP and Dudh Talai WTP and 250 mm for pumps for Patel Circle WTP.

All the structural designs are to be done and got approved by EIC. All the dismantled material is to be transported and stored to central store, no additional payment shall be made for transport and labour. Any damages done to the structure will be repaired by the contractor on his own expenditure.

2. Architectural Works:

As described earlier, this RWPS lies at a major tourist spot and needs to be reimagined/redesigned matching the historical Rajputana architectural monuments that surrounds Pichhola Lake, like City Palace, Jag Mandir, Gangouri Ghat etc. Only pumping station 1 is to be used as pumping station. Remaining structure is to be modified and are to be used as offices. The architenctural design includes both interior and exterior parts of the RWPS Building. The work includes repair of boundary wall of the campus and other campus development works.

Architectural design is to be done keeping in mind the location and heritage of Udaipur. Basic architectural design is done, preview of which is at **PHED/RAJ/SMART CITY/UDZ/TD/WSS/05**. The contractor shall provide architectural design of Dudh Talai RWPS and got it approved by the EIC.

2.10.6.2. **Dudh Talai JEN Office**

The JEN office if also to be modified/ rehabilitated as per approved Architectural Design by EiC as per matching the historical Rajputana architectural monuments that surrounds

Pichhola Lake, like City Palace, Jag Mandir, Gangouri Ghat etc. The work also includes ground clearance and other necessary campus development works including shifting of obsolete mechanical instruments to central store or as per directions of EiC.

2.10.6.3. **Service Reservoirs**

The High Zone and Low zone GLSRs are to be connected to clear water sump of Machla Magra WTP by Gravity flow pipeline. The interconnection is to be done at side vertical walls. The GLSRs require minor rehabilitation to prevent leakages. The work is to be done as per the directions of the EIC. In future in case of leakages, contractor shall do repair works of the GLSRs. The cost is to be added in pipeline scope of work.

2.11. **Instrumentation, Automation and SCADA**

It is required to have fully automatic and safe operation of the pumping station and other water supply components to meet the varied demand of water in most efficient manner. The scope of work shall cover conceptualization, design, pre-dispatch inspections, supply, installation, pre- commissioning tests, commissioning, trial run and operation and maintenance of the entire instrumentation, automation and SCADA System for 10 years including defect liability period of one year, which will envisage water and energy audits. The system should be able to record contibuous readings from flowmeters, pressure transmitters, level transmitters, energy meters etc. so as to enable calculation of efficiency of pumps which are to be operated. The system should be able to arrive at water losses in different sections and in the scheme as a whole. This would be done taking flow meter reading, water pressure at every DMA flow and level reading at every GLSR. The following list is not comprehensive and the scope of Contract shall not be limited by list but shall include all necessary instruments, hardware, software, cabling, earthing etc., which shall be required for proper monitoring of the water pumping system. The system shall have similar equipment at each of the pumping stations. The sizes, ranges and number of signals will vary depending on the number and ratings of pump-motors ;

- Establish 1 Nos. Master Control Centre, at specified location by USCL.
- Establish Local Control Centres at each of the pump houses where PLC/RTU cum IC panel will be installed as per the provisions taken in section 2.7.7.7 – specific requirements
- To provide the required instrumentation and automation at both the critical points at each DMA. Basic data to be transferred from critical poins at each DMA are Flow, pressure and battery power indicators at the inlet point of DMA and pressure, battery power indicators from the other identified critical point of DMA.

- ❖ The monitoring and critical signals from GLSRs, DMAsshall be communicated to the respective local control centres and the master control center simultaneously.

Instrumentation at PHs, SRs, CWRs and DMAs

2.11.1. Flowmeters

The Scope of work includes providing, installation, testing and commissioning of Electromagnetic Flow Meter etc. including all materials and making connections with existing pipeline required for Electromagnetic flowmeter including cutting the existing pipeline etc. complete in all respect as per technical specification and as per the direction of Engineer.

The electromagnetic flow meters shall be installed at following locations;

- At delivery main of each pumpset installed in pump houses
- At inlet of Each GLSR

The detais of flowmeters to be installed shall be as follows;

S.No	Location	Unit	Quantity
1	**At common delivery of pumps at Dudh Talai RWPS**		
1.1	300 MM	Nos.	1
1.2	450 MM	Nos.	2
2	**At the Inlet of GLSRs**		
2.1	250 MM	Nos	1
2.2	300 MM	Nos	1

The number of flowmeters in above table are tentative and their locations is available in Tender drawings. The location & installation arrangement of flowmeters shall be got approved from the Engineer-in-Charge.

2.11.2. Ultrasonic Level Sensor-Indicator-Transmitter

The Scope of work includes supply, installation and commissioning of Ultrasonic level Sensor-indicator-transmitter suitable for measuring liquid level in the sump upto specified depth with microcontroller based system.

The Ultrasonic level Sensor-indicator-transmitter shall be installed at each CWR & GLSR.

S.No.	Ultrasonic level Sensor-indicator-transmitter	Qty	Unit
1	**At CWRs**		
	Depth 0-10 m	1	Nos.
2	**At GLSRs**		
	Depth 0-10 m	3	Nos.
3	**At Lake Pichhola**		
	Depth 0-10 m	1	Nos.

2.11.3. **Pressure Sensor-Transmitter**

The Work includes supply, testing & installtion of Pressure sensors at following locations;

- One pressure sensor-transmitter at Common Delivery pipeline of each pumpset in pumping station
- One pressure sensor-transmitters at theinlet point in each District Metering Area

The details of pressure sensor-transmitter to be installed under this project are as follows;

S.No.	Pressure Sensor-Transmitter Location	Qty	Unit
1	**At DMA**		
	0 to 5 Bar	62	Nos.
2	**At common delivery side of pumps at all the pumping stations**		
	0 to 5 Bar	6	Nos.

2.11.4. **Bulk Flow Meters**

The Scope of work include providing, installation, testing and commissioning of Bulk Flow Meter with removable mechanism class "B" conforming to IS: 4064/1 including all materials including all CI/DI fittings and making connection with existing pipeline required for Bulk Flow Meter including cutting the existing pipeline etc. complete in all respect as per technical specification and as per the direction of the Engineer in charge.

- Bulk Flow Meters shall be installed at inlet of each District Metering Area.

The details of Bulk flow meters to be installed under this project are as follows;

S.No	Particulars	Units	Quantity

1	**At the inlet of DMA**		
1.1	BFM 100 for DN 100 mm	Nos.	1
1.2	BFM 150 for DN 150 mm	Nos.	17
1.3	BFM 200 for DN 200 mm	Nos.	10
1.4	BFM 250 for DN 250 mm	Nos.	3

2.11.5. **Energy Meters & Multi Functional Meters**

The work includes supply, installation, testing and commissioning of 6 Nos Energy Meters on outgoing feeders for pumps at all pumping stations.

The work includes supply, installation, testing and commissioning of 2 Nos Multi Function Meter Meters with power analysis features along with harmonics measurement on all incoming feeders for MCC Panel at all pumping stations to be installed under this project.

2.11.6. **RTU/PLC Panels**

2.11.6.1. **General**

Micro PLC (referred to as controller) shall be provided at each Pumping Station with required number of I/Os to meet the RTU application. It shall be selected considering the envisaged upgrade and it's capability to integrate proposed process instruments for Pumping Station. Controller shall be along with built in or separate GSM/GPRS Modem along with antenna to transfer the data to Master control center.
The controller should have facility to cater IO's to monitor Pump status, Total Flow, Pressure, Chlorination of water etc.

The Controller shall have Ethernet/IP port for peer to-peer messaging – offers users high speed connectivity between controllers, with the ability to access, monitor and program from any location where an Ethernet connection is available.
The Controller having LCD screen shall be preferred which allows user to monitor data within the controller. It shall display status of embedded digital I/O and controller functions as a minimum. The controller should have facility to receive data from respective DMAs & GLSRs to analyse total water flow & water losses.

2.11.6.2. **Other requirements**

The detailed specifications of the equipment proposed to be installed shall be submitted for necessary approval of the Department. The configuration of the system shall adhere

to the principles detailed in the respective Chapter on "Specifications for Instrumentation".

The entire Instrumentation system is required to send the following information to the remote display unit at the main panel in PMCC room in pump house.

In addition to above, the instrumentation system shall transmit data to the PLC system at the respective local control centres also so as to achieve an effective energy and water audit of the complete system.

The entire Instrumentation system is required to receive & store the information From Electrical, Mechanical & Instrumentation Equipment.

2.11.6.3. **Alarm Situations**

Alarm Situations For RWPS

The alarm schedule is indicative of what is required. The Contractor shall provide for the annunciation of all alarms necessary in order to achieve control and monitoring requirements.

- Motor tripped on over-load.
- Clear Water Reservoir full and overflow taking place
- Clear Water Reservoir empty
- Too high or too low pressure on delivery pipeline
- Fire alarm
- 11 kV power failure

2.11.6.4. **Requirement of PLC**

2.11.6.4.1. **Pumping Stations**

Monitor and control of Pump, Valves, Trip/fault signals, Flow control at inlet of CWR, CWR/Sump level, Individual Pump Discharge of each delivery header, chlorine levels and pressure on individual suction and delivery pipe of each pump.

Apart from process parameters, it shall take care of Electrical Power management by monitoring the parameters like power data like V, I, frequency, KW, KWHr, Harmonics etc for the pumping station.

2.11.6.4.2. **DMAs**

Flow, pressure and battery status at one critical point and pressure, battery status at the other critical point.

2.11.6.5. **Drawings and schedules**

a. General arrangement drawings showing installation details.

b. General arrangement drawings of instrument and control panels fully dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.

c. Layout drawings of panel fascias showing instruments, controls and details of all labels.

d. Layout drawings of panel interior showing equipment, terminal blocks and cable ways.

e. Annunciator arrangement and engraving details.

f. Internal circuit and wiring diagrams for instrument and control panels.

g. Schematic control diagrams.

h. Instrument loop diagrams.

i. Instrument wiring and piping diagrams.

j. Interconnection wiring diagrams.

k. Cable block diagrams, drawings and schedules.

l. Instrument system and panel power distribution diagrams.

m. Programmable-device functional design specifications which shall include hardware details, logic flow charts, ladder diagrams and program listings.

n. Schedules of inputs to and outputs from programmable controllers and telemetry outstations.

o. Labelling schedules.

p. Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

All other drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels and the like and for the complete understanding of the operation, maintenance and extension of the system including any required for the Purchaser to dismantle, repair, maintain, modify or extend the Plant.

2.11.6.6. **Specific Requirement**

The work includes following;

A. The work includes supply, erection, testing and commissioning of RTU/PLC cum IC panel with adequate number of analogue/digital I/O's plus 20% spare I/O's, 7" coloured HMI display, GPRS modem installed in control cabin including all external

connections to acquire data from all the instruments at the following pumping stations;

S.No.	Particulars	Qty	Unit
1	Dudh Talai RWPS	1	Nos.

B. The work includes Supply, erection, testing and commissioning of RTU/PLC panel with adequate number of analogue/digital I/O's plus 20% spare I/O's and GSM/GPRS modem for measurement of the following at the DMA centres. The RTU shall be housed in locable metal box of minimum 300mm x 300mm x 250mm size mounted on 100mm x 50 mm MS conduit grouted in concrete block of suitable size and located suitabely at the edge of the ROW adjacent to the property wall with IP-68 protection. The scope of work will include providing and laying of 20 mm dia MDPE casing pipe from flow meter chamber up to the RTU panel through which signal and power cable for flow meter shall be carried. For pressure sensor and transmitter to be located in the RTU panel MDPE pipe shall tap on the HDPE pipe through electro fusion type clamp and for uPVC/ DI pipe through metallic clamp and lead to RTU panel;

S.No.	Particulars	Qty	Unit
1	Flow and pressure	29	Nos.

2.11.7. **UPS**

The work includes supply, installation & testing of 2 KVA UPS invertor with batteries suitable for 8 hrs backup supply to all the instruments and display panels installed at all pumping stations where PLC/RTU Panels are proposed to be installed under this project.

The MCB DB panel shall house the incomer from the UPS invertor and the MCCB/MCBs, indicating lights to individualPanelFeeders as per the SLD provided in he TD.

2.11.8. **SCADA System**

2.11.8.1. **Master Control Center**

The scope of work under this contract is only resctricted to construction of buiding & providing all building services as detailed elsewhere in this document for master control center which will house the IMIS vendor equipment & Staff and PHED Staff.

2.11.8.2. **General Requirement**

The scope of work shall cover conceptualization, design, pre-dispatch inspections, supply, installation, pre- commissioning tests, commissioning, trial run and operation and maintenance of the entire Programmable Logic Control (PLC/SCADA) System for

10years including completion of defect liability period of one year. The scope of Contract shall shall include all necessary instruments, hardware, software, cabling, earthing etc. which shall be required for proper monitoring and control of the water pumping system.

2.11.9. **Investigations & Submissions**

Generally the following activities shall be carried out under this Contract, but shall not be limited to:

i. To carry out the required surveys and investigations and preparing the necessary designs and drawings at the very start of the work. The design offices shall interact with the Department's staff to ensure team work for early submission and approval of the design and drawings required.

ii. Preparation of system designs viz. selection of servers, operator workstations, printers and telecommunications equipment based on specification requirements for approval of the EIC. The entire design works shall be carried out for the system and equipment in total in line with the stipulations as laid out hereinafter.

iii. Detailed design and preparation of the working drawings for the proposed Works, conceptual drawings etc. and all other drawings at appropriate scale and details for planning and construction of all components of the project.

iv. Submission of documents viz. designs, drawings, data sheets, etc. and samples required according to the Contract for approval by the EIC of all design and drawings, material to be used, equipment specifications, etc., prior to construction.

v. Each equipment is compatible for extension in future if required.

vi. Providing and installation of Air conditioning system for entire Master Control Centre.

2.11.10. **Functional Requirement**

- Basic data to be transferred from WTP, CWPH, GLSRs, DMAs, i.e. level in reservoirs, flow, chlorine analyser data, batterey power indicators, status of motors, volatage, amperage etc. and other monitoring signals to be communicated to PLC in respective PH& simultenously the MCC.
- Critical WTP, CWPH, SRs, DMAs signals required for process monitoring shall be communicated from Respective PLC to the connected Control Centers.
- Spare facility should be provided in each Control Center for handling of50% more data for future need.
- All the valves of CWPH/GLSR/CWR/WTP which are to be linked to PLC / SCADA system shall be electrically operated.

Data communication & Master SCADA System INTERFACE:

a) Signals from the GLSRs, DMAsPLC shall be communicated to the SCADA system at master control center and the respective Pumping Station simultaneously.
b) Signals from instruments at Pumping stations shall also be communicated to the SCADA system at Master Control Center
c) For data communication and details of work to be executed in this package refer attached tender drawing.

A. Automation at Pumping Stations

It is proposed to provide control centres at all the pumping stations. The pumping station operations are proposed to be automatic and Programmable Logic Controller (PLC) based. A control room will be provided at each pumping station. Local PLC/RTU systems are proposed for centralized monitoring and operations of the pumping stations by the operators in the control rooms. The contractor will establish interfaces between the pumping station PLCs control systems and the central SCADA system for monitoring the data from the above referred locatons.

B. Interface with IMIS Vendor

Department is in the process of development and implementation of State Level Integrated Information Management System (IMIS) through third party. The contractor would be responsible for providing all the necessary information related to Operation and Maintenance of the Water Supply System, meter management system , consumer complaint redressal system , asset register system, asset condition assessment system, etc. Creating necessary interface and communicating the filtered operational data from city SCADA installed under the contract to central IMIS through GPRS/3G/4G shall be the responsibility of the contractor. For other data inputs , separate modules / workflows could me developed under IMIS and the contractor shall provide necessary input in the modules using PC/Tablet/Smartphone.

If there is any dispute between O&M agency and IMIS Agency, the dispute is to be resolved by performing checks/tests on disputed item in same conditions in presence of EiC and resolving the issue.

C. Functions at Master Control Centre

At the MCC, the SCADA system will acquire the data regarding the water supply system from all the Local Control Centers & All PLC/RTUs at SRs, DMAs by regular polling, process the same and create displays on the screen of the operator station monitors in pre-assigned formats. A Wide Area Network (WAN) will be established for this purpose. The SCADA system will integrate the controls at all the pumping stations, distribution reservoirs. The data in the SCADA system will be updated at a regular interval of 15

minutes and will be stored in the memory units for future reference. The data will be archived for maintaining long-term records. Additional 20% extra space shall be provided in all the panels at MCC.

D. Telecommunication

Telecommunication system is required for data transmission between the MCCs and LCCs and all connected PLCs/RTUs. The bandwidth requirement has to be adequate to meet the polling time cycle of 15 minutes to cover all the nodes on the wide area network. In case own network is maintained for this project, it would become difficult to upgrade the same in line with changes in technology. Also, it is difficult to retain qualified staff in this hi-tech field. Nowadays, reliable services are available by the telecommunication service providers and the same are proposed to be used for this project by installing a Virtual Private Network/GSM/GPRS.

For the distribution centres General Packet Radio Service (GPRS) mobile links are proposed. The telecommunication network and flow of data via the telecommunication network will be controlled by the communication server to be installed at MCC.

E. SCADA System Software and hardware

The SCADA software will facilitate centralized monitoring of water supply system operations by viewing real time operational data at all the water works in pictorial / graphical form which will include status of pumps, open / close status of motorized valves, readings of flow meters, energy meters, pressure and level instruments and status of energy meters & multi function meters etc. The other functions will include generating and recording of alarms along with time of stamping, data logging and generating trends and maintain records of all the data, printing of alarms and events, report generation and also remote operations. The software to be used will be established branded and licensed software proven in the industry for similar applications. It will have facilities for calculations, various algorithms, logic operations, ready reference data look-up tables etc. The prediction of transfer of water will be done based on statistical study of past records. The software will be user friendly and will facilitate the operations without complex tasks by the operator and will provide all the support required to take decisions.

2.11.10.1.1. Specific Requirement

The work includes supply, Installation and Commissioning of PC Server, Central Water Distribution Monitoring and Control software, Database, SCADA software, Automatic Report Generation software at Office cum SCADA Rooms at Master Control Centre consisting of the following components as a bare minimum;

- High end dual redundant servers complete with data storage and archiving, 21" LCD screen, mouse, keyboard, wiring, cables and all accessories.
- Dual redundant fast ethernet hub and bus wiring installation complete including connection of all SCADA equipments, with all accessories.

- ❖ High end PC SCADA operator stations with 21" LCD Screen, mouse, keyboard and all accessories.
- ❖ M2M Communication Gateway
- ❖ ISDN and GPRS modems for telecommunications complete with all wiring installations and connection to ethernet bus with all accessories.
- ❖ Wall mounted 46" LCD screens for 'Mimic type' displays, wiring, cables and all accessories.
- ❖ Laser printers, wiring, cables and all accessories.
- ❖ UPS suitable for the server, LCD monitors and other server room equipments with 8 hours battery back-up.

2.12. **Tools & Tackles**

2.12.1. **Supply of Leak Detection Equipment**

The Contractor shall supply metal and non metal pipe line locator with water leak detection . The set of leak detection consistes of following 3 kits

i. Water leak detector

ii. Cable and pipe lone locator.

iii. Non metallic pipe line locator.

2.12.2. **Supply of Tools & Tackles**

The Contractor shall supply tools and tackles for pipeline, pump house and laboratory work to the department before the commencement of O&M contract period as following.

Tools & Tackels			
S.No	Description	Unit	Nos.
1	Digital clamp meter 1000 A ac	Nos	3
2	Infrared thermometer irl - 380 range :- 50 to 380* C	Nos	3
3	Digital vibrometer	Nos	3
4	Db meter	Nos	3
5	Digital insulation tester 1000 v 2000 mohms	Nos	3
6	Analog insulation tester 1000v 2000 ohms	Nos	3
7	Safety gloves pair	Nos	3

8	Hydraulic crimping tool upto 300 sqm	Nos	3
9	Digital multimeter 31/2 digit 1999 count lced	Nos	3
10	Digital multimeter	Nos	3
11	Digital multimeters 3-3/4	Nos	3
12	Screw driver set	Set	4
13	Hammer of 200 gm, 450 gm, 1 kg, 5 kg, & 20 kg, weight	Set	3
14	Set of Ring spanners & Fixed spanners (covering all sizes)	Set	4
15	Round files of sizes 6" and 10" medium cut type	Set	4
16	Hacksaw frames 12" with 24 blades	Set	4
17	Pipe wrench 10", 14" and 18" of ISI mark	Set	4
18	Aluminum folding ladder of 8 meter	Set	3
19	Set of Tommy	Set	4
20	Diesel driven self priming de-watering pumps of 2 lps, 10 m head with 5 m hose pipe.	Set	2
21	Tripod with Chain Pulley Blocks of 1 Ton Capacity (6.0 m legs)	Set	1
22	Gas cutter with nozzles and two cylinders	Set	1
23	Insulating Fuse Puller for all types of fuse to be used in project components	Set	2
24	Nose pilers ISI mark	Set	3
25	Hydraulic jack, 5 Ton capacity	Set	2
26	Pipe dye set½" to 2"	Set	2
27	HDPE pipe welding Machine (Jointing Machine)	Nos	1
28	Portable Genertor DG set	Nos	1

2.13. **Laboratory Equipment:**

Supply of Electrode for Ion Meter – 2 Nos

2.14. **Energy Efficient LED Lighting**

The Contractor shall supply and fixing of following set of energy efficient lights at Dudh Talai RWPS and Machla Magra WTP Campus and Patel Circle Administrative Office:

S.No	Description	Unit	Qty.
1	75 WP Luminous Solar Modules 40 Ah Luminous solar Tubular Batteries 5 m heigh M.S coated pole (including solar battery Box & Panels Stand) 12 W Solar Street light Luminary.	No.	8
2	100 WP Luminous Solarmodules 75 Ah luminous solar tubular Batteries 5 m M.S coated pole (including solar battery box & panels stand) 18 W solar street light luminiary	No.	8
3	M.S Tublar pole light 5 mlong OD in mm 88.9x3.25=3 m 76.1x3.25= 2 m single arm 40.1x3.25=1 m with 20 w LED street light.	No	7
4	M.S Tublar pole light 5 m long OD in mm 88.9x3.25=3 m 76.1x3.25= 2 m single arm 40.1x3.25=1 m with 36 w LED street light.	No.	2
5	1 Meter long Bracket 32 mm G.I with 20 w LED street light.	No.	5
6	Batten TME 501/1 LED	No	40
7	Battery TCM 501/ 2 LED	No	15
8	LED Tube Essential 18 W	No	70

2.15. **Spare Parts**

Contractor shall supply spares for pumps, pipeline works etc to the department before the commencement of O&M contract period;

A. For Pumps

S.No.	Particulars	Qty	Unit
1	Complete set of Rotating Assembly of each type of supplied pump	1	Nos.
2	Set of Motor bearings of Each type of motor supplied with pump.	1	Nos.

S.No.	Particulars	Qty	Unit
3	MCCB /MCBs	1	Nos.
4	Voltmeters Digital type	1	Nos.
5	Ampere meters digital type	1	Nos.
6.	One contactor of each rating provided in panel.	1	Nos.
7.	Multifunction meter	1	Nos.

2.16. Operation & Maintenance for 10 Years including one year defect liability period:

The works included are as defined below:-

2.16.1. General

The scope of O&M for 10 years (including one year defect liability period) shall include following;

- Operation and maintenance of distribution system of ABD area.
- Operation and maintenance of all works executed at all the headworks under this contract including civil, mechanical, electrical, instrumentation, automation, SCADA, chlorination etc.
- O&M of rising mains (with all pipe appurtenances & ancillary structures) laid under this contract.
- O&M of all reservoirs (CWRs/GLSRs),
- O&M of all Instrumentation, Automation & SCADA works constructed under this contract.
- Operation & maintenance of distribution pipelines laid under this project.
- Operation & maintenance of Water Treatment Plant and associated works constructed under this project.
- Operation & Maintenance of Consumer meters installed under this project& of those installed during O&M period.
- Providing new consumer connections during O&M period. The contractor shall make provision for all material like pipes, sockets, ferrule, saddles etc, manpower for providing new water connection in O&M cost.
- Ensure collection of all information of field instruments by PLC/SCADA system.

- Shall maintain the consumer care centre during entire O&M period and defect liability period.

The O&M of the scheme shall be run with a well developed quality management system as per guidelines of ISO 9001:2008 revised up to date. The contractor, within 12 months of commencement of O&M, shall obtain ISO 9001:2008 certifications from one of the following firms:

a. Bureau Veritas India

b. TUV India of TUV-Nord Group,

c. DNV (Det Norske Veritas)

d. Direct Assessment Services, Chennai

e. SGS India Pvt Ltd, Chennai,

The contractor shall update the O&M Systems and Procedures developed as per department's requirements and as per ISO guidelines. The same shall be submitted to the department for approval along with other O&M documents like O&M Manuals, Log sheets, Formats, etc. These shall be got audited annually throughout the O&M period.

The Contractor shall comply with all requirements for O&M of water supply system as provided in updated Manaul on Operation and Maintenance of Water Supply Systems(January 2005) published by CPHEEO, Ministry of Urban Development, New Delhi.

Within the frame work of the contractors responsibilities given above, the contractor shall carry out the following activities, but these shall not limit requirement of other activities, which otherwise are required as per term and conditions of contract or to fulfill contractors responsibilities or are essential as per good industrial practices. The contractor shall be responsible for:

a. Providing designed per day requirement of water to each GLSR and from each GLSR to each zone. System shall be tested for design demand but shall be run as per actual demand based on population as per directions of EIC.

b. Chlorination of water in CWR as per requirement for which liquefied chlorine shall be provided by the department. However, the department may ask the contractor to supply the chlorine for which actual cost shall be reimbursed to the contractor on production of the bill.

c. To check the residual chlorine at the tail end of each zone. It should be as per CPHEEO manual requirement.

d. Providing the minimum specified staff as specified in Clause 2.12.2 during operation and maintenance period and additional staff as per requirement during periodic maintenance and in emergencies.

e. Providing all required consumables required for functioning/operation & maintenance of equipment.

f. Metering is of utmost importance in this contract. Flow measurements of meters atPumping stations, WTP, CWR/SRs, at each DMA will be recorded daily through SCADA system. In case of SCADA being not functional, The contractor shall make arrangement of recrding the reading from Bulk meters on daily Basis and Manually entering the flow data in IMIS software/other system as directed by Engineer-in-Charge.

g. Preventive/breakdown maintenance of all pumps, electrical, mechanical & instrument equipment, installed under the contract. All costs including costs of all material, equipment, etc required for operation and/or maintenance (preventive and/or breakdown) to be borne by the contractor.

h. Maintenance of the lighting fixtures and the lighting system of all areas and replacement of all non-functional lighting fixtures within 24 hours.

i. Maintaining;

- Repair history of all pipeline, mechanical, electrical and instrumentation control equipment Logbooks:

    i. Every day power availability, input voltages, kWH meter, power factor readings at each pumping station and WTP.

    ii. Daily Operation of pumps with every hour readings for operating voltage, amperage and power factor, pressure on the manifold, pressure at outlet of pumps and flow rate in manifold.

    iii. Maintain record of net operating pressure, discharge and energy consumption of each pump so as to arrive at the operating efficiency. This record should be logged through the PLC installed in the pumping station.

    iv. Calculation of monthly actual power consumption bill and comparison with daily calculated maximum power consumtion as per guaranteed actual raw water production and treatment as per different lake level. The format of comparison sheet is at **Annexure-2.**

- Last periodic maintenance done for all reservoirs of the system.

- Observations made during patrolling of the pipeline.

In addition to maintenance of above logbooks, the contractor is required to maintain one observation book at each pumping station. Observations made in the observation book, by departmental officers, must be complied with immediately and compliance report shall be sent monthly to EIC.

j. Providing tools and tackles and spares, at the start of the O&M period, as per list given in scope of work and maintaining adequate additional inventory of spares/accessories or equipment itself for repair of system so that the electrical, mechanical, pipe and pipe appurtenances, can work efficiently as per the guarantees given or minimum required efficiencies asked for in the contract, without any additional costs to department.

k. Providing manpower and materials for the required repairs of all facilities along with the manpower and materials for repair of the buildings, reservoirs and pipeline built under the contract.

l. Maintenance of the stores for the electrical, mechanical and instrumentation equipment. The maintenance of stores will include but shall not be limited to:

   - ❖ Loading / unloading of materials received and issued for works.
   - ❖ Proper arrangement of material in stores to ensure its safety and easy availability.
   - ❖ Maintaining store area neat and tidy.
   - ❖ Keeping records and Accounting the incoming materials
   - ❖ Keeping records and Accounting the consumed materials

   The contractor shall be solely responsible for the safety and security of the goods in the store and its accountability and will be responsible for any loss or damages in stores for any reason. He may opt for insurance cover against the value of the goods to be stored without any additional costs on the Department.

m. Patrolling of the water mains laid in the contract, to identify and report the damages / defects pipe and pipe appurtenances, CD works, en-route structures.

n. Emergency Maintenance/Periodic routine maintenance: Providing a fleet consisting of suitable hauling machine, sufficient inspection/patrolling vehicles and material hauling vehicles and any other vehicles/machinery/equipment for adequate and timely repairs and/or for routine/periodic maintenance /patrolling of the system.

o. Periodic routine maintenance of buildings & reservoirs constructed under this contract. Such maintenance must ensure adequate cleanliness, ventilation, illumination and structural safety. In addition to this, the general hygienic standards must be maintained and adequate plantation should be done.

p. Maintenance of road-cut repairs carried out under the contract.

q. Updating and periodic submissions of the operation and maintenance manual as defined in specifications for O&M works. The contractor shall take up all periodic maintenance works provided in the approved O&M manual.

r. The contractor shall prepare weekly, monthly, quarterly, reports for all operations regularly as described which should be accessible to all the concerned persons of the department from any where at any time.

s. Co-ordination with other contractors and/ or agencies responsible for the Execution, operation and maintenance for regional schemes and Electric Supply Company.

The O&M period shall commence after complete execution of the project as defined in contract document and one year defect liability after award of work or actual date of completion of defect liability period whichever is later. However, the part commissioning of the project on completion of certain units, if possible, before completion of execution period, and if Department desires to use these units, the same shall be put to O&M without reckoning such period towards the 6 years period of O&M, however charges for power shall be borne by the department during this period.

During Operation & Maintenance either after commencement of the O&M period as mentioned above or during execution period i.e. part operation & maintenance if required by department due to part handing over of the system before completion of execution period, the following charges towards O&M shall be paid by the Department / Contractor.

- Power charges shall be paid by department. Any power factor surchargeif levied by power supply agency or losses in incentive due to power factor less than 0.98 shall be borne by the contractor.
- 50%of the incentive given by AVVNL for maintaining PF above 0.98 shall be admissible to contractor.
- If the power consumption is more than the accepted guaranteed power calculation, the extra amount is to be borne by the contractor. The calculated guaranteed power calculation is at **Annexure-1.**
- Chemical i.e. liquefied chlorine shall be provided by the department. However, the department may ask the contractor to supply the chlorine for which actual cost shall be reimbursed to the contractor on production of the bill.
- All other cost involved for O&M viz. cost of spares, staff, communications, consumables, stationery, T&P, vehicles etc. shall be borne by the contractor.

Under this contract, the contractor is required to operate and maintain all the works carried out at all pumping stations including all civil, EMI and ancillary works executed under this contract, WTP, CWRs, GLSRs, Rising mains (laid under this contract) from Raw water Pumping stations to GLSR for the entire period specified in the contract

A joint inspection shall be carried out before commencement of O & M work and following documents shall be inspected:

- ❖ As built drawings of civil works and EMI works, test reports of pump/motor/valves shall be displayed on wooden board duly laminated in respective pumping station.
- ❖ O&M Manual
- ❖ Log books (formats)

During operation and maintenance the contractor shall ensure that the Department gets the required and envisaged flow(s) at Existing & proposed GLSRs and each zone in turn receives the quantity of water as per requirement at desired pressure.

The duties of the contractor under this contract shall include the following but shall not be limited to:

a. Identification and obtaining all the clearances required for the operation of the facility and for the fulfillment of its obligations under the Conditions of Contract.

b. Arrange all the necessary manpower & services for the operation and maintenance of the system as per scope defined above including normal watch & wards etc.

c. Make all necessary arrangements for the tools and plants, machinery, equipments, furniture and transportation vehicles necessary for operation and maintenance and timely repairs.

d. Procure and store all required materials, equipment, lubricants, inventory for repair and operation and maintenance at such locations.

e. Be responsible for the security of the facility and comply with applicable laws and/or statutory requirements as may be applicable in the land from time to time.

f. Co-ordinate and communicate with other agencies like PWD, Railway, Electric Companies, Water Resources Deptt., Telephone Deptt. etc.

g. Be responsible to minimize wastage of water by attending to leakages of pipe, air valve, scour valve etc. and breaches immediately and shall repair/restore within 12 hours from the notice of such leakage / breach. In no case the down time of the pipe/machine should exceed 12 hours.

h. Pump/motor/transformer/capacitor bank etc. should be repaired quickly within reasonable time in order to avoid down time of the system exceeding 12 hours.

i. Maintaining, foolproof operation of all PLC and SCADA systems at all locations round the clock uninterrupted. Any fault in PLC system, it should be rectified within 24 hours.

j. Maintaining the 33/0.415 KV and 11/0.415 KV sub-stations at each headworks as per standard practice/norms.

k. Ensure adoption of newly developed energy conservation measures/regulations viz energy audit, CFL lighting etc.

l. The power factor of electrical system at all location should not be less than 0.98. The power factor surcharge / load surcharge billed by Electric Company or loss in incentive in any month of O&M period or part O&M period shall be recoverable from the contractor's monthly O&M bill.

m. Be responsible for most efficient use of power in running of plant and machinery even lighting load.

n. The Contractor shall carry out his activities in the facility in such a manner that water will not be wasted, leaked or spilled onto the site or elsewhere. The Contractor shall bear the cost of correcting any adverse consequences resulting from such wastage, leakage or spillage, and shall maintain history of such event in history sheet.

o. The contractor shall keep records for daily water drawl from all pumping stations through SCADA system which shall include Flow rates, pressure, operation state of pumps at each head works, chlorine doses, flow & pressure at each GLSR, operational status of all mechanical, electrical & instrumentation equipment. The record shall be kept in formats as approved by EIC. Contractor shall submit these records to EIC on fortnight basis.

p. The contractor shall prepare weekly, monthly, quarterly, reports for all operations regularly as described which should be accessible to all the concerned persons of the department from any where at any time

q. . Monthly report should also be submitted in hard copies.

r. Maintaining the drinking water supply facilities in all pump houses, office & residential buildings and all its units.

s. The plantation done on headworks should be maintained and dead plants should be replaced.

t. To keep the entire campus area, particularly toilets neat and clean and dis-infected by using Phenyl, acid and other chemicals at all head works.

u. Up keeping and maintaining all illumination system, internal and external at all head works by changing the default equipment immediately.

2.16.2. **Deployment Of Minimum Staff for O&M**

The minimum permanent staff to be deployed for each section by the contractor for carrying out the O&M functions shall be as follows:

S.No	Category	Qualification	Min. Experience	Project	Pump House	WTP	Pipe line/Water Meter	Total
1	Manager	B.E. Civil/ Mechanical/ Electrical	5 Years	1				1
2	Hydraulic Engineer	B.E. Civil	5 Years with experience in WATERGEMS Software	1				1
3	SCADA Engineer	B.E. Instrumentation/ Electrical	5 Years	1				1
4	Leak Detection Expert	Diploma/ Degree-Civil	2 Years Experience in Leak Detection	1				1
5	Chemist	B. Sc.	3 Years in water testing			3		3
6	Filter Attendent	Diploma-Civil	5 Years			6		6
7	Pump Operator	I.T.I	5 Years		3			3
8	Electrician	I.T.I	5 Years	1				1
9	Cleaner/Sweeper	-	-		1	1		2
10	Watchman	-	-		1	1		2

S.No	Category	Qualification	Min. Experience	Project	Pump House	WTP	Pipe line/Water Meter	Total
11	Fitter	I.T.I	5 Years				2	2
12	Helper	8th Pass	-		3	3	2	8
	Total			**5**	**8**	**14**	**4**	**31**

Note:

a. The above requirement is minimum only. The contractor will arrange extra work force, as and when required, so as to smoothly run the repair and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.

b. The above staff strength is exclusive of leave/rest reserve required for different category of staff. The contractor shall ensure, the personnel given in the above table for all the seven days in a week.

c. The contractor shall make appropriate arrangements for maintenance of items like patrolling, vehicle operations and other activities defined to fulfill its obligations under R&M contract.

2.16.3. Consumer Care Centers

The contractor shall maintain the consumer care centre for entire period of Operation & maintennace including the defect liability period as per following requirements;

- Shall provide & maintain a toll free telephone number at consumer care centre
- Shall maintain a reception desk with adequate manpower at centre with adequate facility of sitting, drinking water, ventilation, HVAC etc.
- Shall maintain a register to record all compliants recieved and keep a complete/ transfer the data to IMIS on daily basis and track of these complaints till thier resolution.
- Shall inform the consumer after the complaint is resolved.
- All forms shall be available at consumer care centre.
- The consumer care centre shall provide a pleasant, healthy, hyiginic environment to consumers.
- Shall provide daily, weekly & monthly reports to department on consumer complaints. The format of these report shall be got approved from Engineer-in-charge.

2.16.4. **Pipeline Works**

The contractor shall maintain all pipelines including pumping mains & Distribution pipelines which includes following duties & responsibilities;

a. Maintaining everyday observations including meter readings of all electromagnetic meters installed on the pipeline.

b. Repair of leakage's, damage to any portion of pipes and pipe appurtenances, pillars, thrust blocks etc., and shall be done to within 12 hours from identification.

c. Emergency Repair(s) of burst(s) for maintaining regular supplies immediately.

d. Operation of all valves quarterly to check its functioning for operation. Maintenance of all valves. Inspection of surge protection equipment/system if any and repair them if required. Contractor shall submit quarterly reports of all such activities done.

e. To maintain minimum level of inventory required for repair of pipe leakage(s) and burst(s), valves (air valve, sluice valves, butterfly valves), flow meters, surge protection devices or any other pipe appurtenances or equipment(s) installed.

f. Quarterly lubrication of all gear boxes along the alignment.

g. To maintain the valve chambers along the pipeline in clean and dry conditions.

h. To make necessary arrangements for de-watering in situations warranted for O&M.

i. To maintain the soil cover on the pipe damaged due to rains, run-off or due to other reasons.

j. Maintaining clean conditions at pillars and fixity blocks along pipelines.

k. Maintain all the existing rising and distribution pipelines within the project area.

2.16.5. **Pumping Stations**

The contractor shall maintain all Pumping Stations at all head works which includes following duties & responsibilities;

a. Maintaining everyday observations including meter readings of all electromagnetic meters installed at pumping stations.

b. Chlorination of water in CWR as per requirement for which liquefied chlorine shall be provided by the department. However, the department may ask the contractor to supply the chlorine for which actual cost shall be reimbursed to the contractor on production of the bill.

c. Routine maintenance of the pumps and motors as per recommendation of the manufacturers.

d. Routine maintenance of the entire control system and instruments as per recommendation of the manufacturer.

e. Operating pumping machinery at maximum efficiency with maimum loss of efficiency of pumpsets **0.4%** in a particular period during complete period of O&M.

f. The contractor shall be responsible for keeping SCADA system fully functioning for all times. Suitable arrangement shall be made for preventing loss of data during any breakdown.

g. Replacement of damaged control, communication and power supply cables.

h. Repair/replacement of all instruments such as flow meters, pressure gauges, level-sensors, float levels, temperature scanners, vibration and noise meters along with all other equipments. The down time of any individual instrument as referred above shall not exceed 12 hours.

i. Periodic calibration of all measuring/metering equipments and resetting of all relays at every sixth month.

j. To maintain all consumables for printing without any additional cost to the department.

k. To produce and submit daily and monthly customized reports from each pumping station using SCADA system.

l. Repair/replacement of damaged electrical equipments/parts for proper functioning of electrical system.

m. Maintenance of cooling and lubrication system.

n. Replacement of bearings, neck rings, and impeller rings; shafts, sleeves/bushes, damaged impellers etc. and other damaged parts so that the operation of pumps ensures the guaranteed efficiencies with desired noise and vibration levels.

o. Routine & periodic maintenance of the cranes as per recommendation of the manufacturer.

p. Breakdown maintenance of all electrical, mechanical & instrumentation equipment etc.

q. Re-painting of the exposed mild steel pipeline specials pumps, motors, valves, ladders, railings and steel structures like entry gate, grating etc in the P.S. campus after 36 months of completion of DLP to keep them in good shape.Repainting of lighting poles and structures and other electric equipment in the 3rd, 5th, 7th 9th year of O&M.

r. Repainting annually suction pipeline projected in sump including bell-mouth, sluice gates, trash-racks, level gauges and other steel structures in contact with water.

s. To keep the surrounding areas of the pumping stations free from shrubs, grass and other vegetations.

t. To maintain/ shorten the gap uniformly between neck and neck ring of all pumps as per recommendation of the manufacturer.

u. Be responsible for maintaining the required Power Factor at all the pumping stations. Additional capacitor banks shall be added wherever required due to de-rating or other wise. The contractor shall add capacitance by additional capacitors with all loads, so that average monthly power factor remains not less than 0.98. Contractor shall be liable for recovery of power factor surcharge billed by AVVNL or loss in incentive for Power factor below 0.98 for his failure to maintain power factor. 50%of the incentive given by AVVNL for maintaining PF above 0.98 shall be admissible to contractor.

v. Cleaning the pump house from inside & outside daily.

2.16.6. **Grid Sub-stations**

The contractor shall maintain all Electric Substations at all head works which includes following duties & responsibilities;

a. Routine and periodical checking of all equipments and structures installed at switchyard to ensure their normal functioning.

b. Regular cleaning of switchyard to ensure no growth of any kind of vegetation.

c. Regular checking of oil levels in all types of transformers and to supplement as and when required and the contractor to arrange oil filtration at his level whenever required.

d. To keep all joints leads, nut bolts in tightened position.

e. To maintain all relays in healthy condition and to recalibrate in 3rd and 5th year.

f. To maintain the required earthing level.

2.16.7. **Water Treatment Plant:**

The Contractor shall carry out following maintenance work, during O & M period :

a. Repair of damaged portion of WTP units.

b. To operate and check all valves, instruments and automation systems once in 3 months and do the required maintenance work to ensure their smooth and proper functioning.

c. Repainting during the 5thand 9thyear of O&M period

d. To maintain the WTP, its surrounding and the campus in a neat and tidy manner.

e. Other activities required for maintaining the WTP and their surroundings in neat conditions.

f. Maintaining everyday observations including meter readings of all electromagnetic meters installed at WTP.

g. Routine maintenance of the pumps and motors as per recommendation of the manufacturers.

h. Routine maintenance of the entire control system and instruments as per recommendation of the manufacturer.

i. The contractor shall be responsible for keeping SCADA system fully functioning for all times. Suitable arrangement shall be made for preventing loss of data during any breakdown.

j. Replacement of damaged control, communication and power supply cables.

k. Repair/replacement of all instruments such as flow meters, pressure gauges, level-sensors, float levels, temperature scanners, vibration and noise meters along with all other equipments. The down time of any individual instrument as referred above shall not exceed 12 hours.

l. Any other works for smooth and efficient working of WTP units.

2.16.8. **Water Reservoirs (CWRs/SRs):**

The Contractor shall carry out following maintenance work, during O & M period :

a. Repair of damaged portions of reservoirs.

b. To operate and check all valves, instruments and automation systems once in 3 months and do the required maintenance work to ensure their smooth and proper functioning.

c. Cleaning and bleaching of the reservoir once in 6 months as per direction of Engineer in Charge. The date of cleaning and bleaching shall be painted on the signboard installed near the reservoir.

d. Repair of the damaged portions of the plinth protection works.

e. Repainting during the 5thand 9thyear of O&M period

f. Repainting the exposed surface of mild steel ladder, railing, angle, manhole covers, campus gate etc in 3rd, 5th, 7th, 9th year of o&m period to keep them good.

g. To maintain the reservoir, its surrounding and the campus in a neat and tidy manner.

h. Other activities required for maintaining the tanks and their surroundings in neat conditions.

2.16.9. **House Connections & Water Meters**

The contractor shall maintain all house connections & water meters which includes following duties & responsibilities;

- During design & execution phase, The contractor shall collect data of all existing pipelines & those laid under this project & create geo-refrenced maps giving a unique identification to each pipe, appurtenances etc having refrence to its DMA & Hydraulic zone. Similarly, the contractor shall also identify all the existing water connections, correlate it with pipe on which it is installed, collect their GPS coordinates and update this information with pipe data & consumer data available with department. The Contractor shall provide unique identification number to each of house connection. The methodology of providing unique identification number to pipes, appurtenance&consumer connectionsand formats for collection information shall be got approved from EIC.

- If required, the contractor shall repair any damaged consumer service pipeline, ferrule etc as per dirctions of EIC.

- The Contractor shall provide new connection to consumer as per instructions from Engineer-in-charge. For this Contractor shall provided all manpower, material such as pipes, bends, elbow, saddle, ferrule etc, for which contractor is advised to take provisions in its quoted O&M cost. The Contractor shall collect all the consumer data, take photographs before & after connection, gather Geograhical location of consumer through GPS and update all this information on IMIS server. The water meter shall be provided by the department.

- The Contractor shall disconnect a water connection, take photograph of water meter, collect all required data as per instructions of engineer-in-charge and update record in IMIS server.

- The contractor shall shift a water connection as per instruction of engineer-in-charge, collect all data, take photographs at old & new location, take GPS coordinates of new location and update all information on IMIS server.

- The contractor shall make arrangement/facilities for testing & calibrations of water meters on complaints from Consumer & instructions from Engineer-in-charge. The contractor shall remove the water meter, test & calibrate the meter and replace the water meter, if required.

- The contractor shall take periodic inspection of all pipelines, service lines, water meters to detect any leakge, theft, damage, sabotage etc. On any such incident, the Contractor shall notify the same to EIC & take suitable remedial measure immediately.

- The contractor shall do all operation & maintenance work with regard to house connections & water meters as per directions of Engineer-in-charge.

2.16.10. **Ordinary Repiars**

The contractor shall also carry out the ordinary repair to buildings during the O & M period. The repairs may include but not limited to items: -

a. Easing of doors and windows, monsoon repairs to roofs, attention to drains, rainwater spouts and attention to plinth protection.

b. External white or color wash, external or internal painting, internal distempering, renewal of approach roads within the campus.

The frequency of repairs must not be less than as specified below:

S. No.	Nature of Repair	Frequency of Repair
1.	External finishing of residential quarters, office buildings and pump houses (color washing) after attending minor repairs such as damage to plaster, pointing etc.	36 months after completion of DLP
2.	Internal finishing of residential quarters, office buildings and pump houses (distemper/painting) after attending minor repairs such as damage to plaster, floor etc.	36 months after completion of DLP
3.	Painting of woodwork & steel works including shutters of residential quarters, office buildings and pump houses.	36 months after completion of DLP
4.	External finishing (Distemper/painting) after attending minor repairs of all CWRs	36 months after completion of DLP
5.	External finishing (Distempering/painting) after attending minor repairs of all GLSRs	36 months after completion of DLP

2.16.11. **SCADA System**

Under this Contract, the Contractor is required to operate and maintain the SCADA System for the entire period specified in the Contract (as at commencement date of O&M period and all the additions, alternations done under this Contract) for the purpose of monitoring and controlling the transfer and distribution of treated water. The

contractor shall engage minimum one experienced PLC/SCADA Engineer during the whole contract period.

2.16.12. MAINTENANCE OF C.D. WORKS AND OTHER STRUCTURES:

This will generally involve the following activities bi- yearly:

1. Clearing of the silt and vegetation obstructing flow of water in the waterway of drains/rivers.
2. Repairs to the damaged portions of the structures viz. cut off walls, apron, parapet walls etc.
3. Reporting of any serious abnormality / conditions to the Executive Engineer and taking necessary actions.
4. Cleaning of carriage way & maintaining the approach roads for smooth safe mobility of the vehicles.

2.16.13. Civil Structure (Campus Area, Road, Residential Buildings , Office, Store, Boundary Wall etc.)

This will generally involve the following activities:

(a) To implant new plants at different head works, planned and rowed as per instructions of EIC during execution of work and shall maintain the growth and make good of dead plants during complete period of O&M.

(b) To plant and maintain a lawn at all headworks or as directed by EIC, surrounded by flowering / decorative plant rows.

(c) All arrangements for maintaining the plantation/ lawn viz. pipeline, valves, tools & tackles, fertilizers /pesticides, lawn mover etc. shall be done right from execution of the work at all head works.

(d) Inter cultural operation such as hoeing and weeding etc.

(e) Pruning and trimming and cutting of the plants and trees as per requirement.

1. To remove shrubs, grass and unwanted vegetation's after each rainy season from the campus area.
2. Maintenance of roads and lighting fixtures and lighting circuits at all headworks.
3. Maintenance of all pump house buildings, and ancillary structures including compound walls and barbed/chain link fencing.
4. Maintenance of lighting fixtures and lighting circuits water supply facilities in campus, offices and other buildings.

5. The contractor shall carry out the ordinary repair to building during the O & M period. The repairs may include but not limited to items: -
    i. Repair of damaged portions of any civil structure constructed under the project.
    ii. To repair any damage in the Electrical, Sanitary & other installations to keep functional.
    iii. Repair of the damaged portions of any constructed work.
    iv. Repainting, 36 months after completion of DLP.

Following repairs prior to onset of monsoon are essential:

1. Any faults in the electric installation, leakages, earthing, exposed wire ends and any hazards on this account to the users/inmates of the buildings, should be taken care of suitably, wiring, which is damaged or outlived, should be replaced.
2. House drainage/ sanitary system should be properly cleared, repaired/replaced.
3. Proper drainage of the area around the all pumping stations area should be ensured to avoid stagnation of rainwater effluent.
4. Leaking roofs should be attended to immediately with suitable repairs/ treatment, as the case may be.
5. The damaged plaster/pointing on outer walls of the building, which is exposed to weather, should be repaired before rains in order to prevent dampness inside. Where plinth protection has been provided, it should be checked and the damaged portions, if any, should be repaired before rains.
6. Damaged flooring should be repaired/ replaced as per requirement, in order to prevent dampness inside the rooms, etc. during rains.
7. Periodic repairs of damaged floors, door/window fittings, water taps, electric circuits, must be taken up on complaints using the material of same quality as used during construction.
8. All GLSRs & CWRs are to be cleaned and disinfected every six month and cleaning date should be marked on GLSRs/CWR wall by paint.

2.16.14. INSTRUCTION/ GUIDELINES/ SPECIAL PRECAUTION TO BE FOLLOWED BY THE CONTRACTOR

1 Line valves should not be closed and scour valve should not be opened when water is being pumped in pipeline. In other words, normally all valves should remain in open position except scour valve.

2 In case of repair/ maintenance in the pipeline/ appurtenances, the same shall be immediately referred to the upstream and down stream pumping stations stating the nature of repair/ maintenance and the estimated time required to correct it. The approval of rectification/ repair should be sought from the Engineer-in-Charge.

3 During maintenance of valves/ appurtenances and leakage/ burst, all safety precautions, rules and regulation prescribed by other agencies such as PWD/

Telcome/ Electricity Board/ Mining Department/ Revenue Department, Transportation Department/ Labour Department and any other related agency shall have to be followed strictly in case of non compliance of rules and regulations, the damages so caused, if any shall be the responsibility of the contractor and cost accured thereof shall be borne by the contractor.

In case of heavy leakages in pipeline observed due to burst of pipes, through welding joints, valves leakages then closing of the nearest butterfly valve and sluice valve in line of the upstream and down stream of the leakages point and opening of scour valve in this section only after the stopping of the pump and after rectification closing of scour valves, opening of in line valves which were previously closed for repair before starting of pumps. Leakage once repaired should be monitored.

INVENTORY REQUIREMENT FOR O&M OF EXISTING SYSTEM

SN	Equipment/machinery	Minimum Capcity	Nos. required
1	Chain Pully Block with tripod	2 MT	1 No.
2	Generating set Trolly Mounted	10 KVA	1 No.
3	Welding set	300AMP	1 No.
4	Dewatering pump set Trolly Mounted	50000 Ltr. Per hour	1 No
5	Gas cutter with gas cylinder		1 No. with two nos. extra set of gas cylinder

Above referred machinery is minimum required for O & M of pipelines however if during breakdown/ maintenance more machinery is required the contractor is required to arrange the same immediately so that repair work of pipeline should not be delayed. Arrangement of JCB and crane etc. has to be made as per requirement.

2.16.15. **Additional Responsibilities**

i) Consumables

All consumable items e.g. lubricating oil, grease, bulbs, tubes, gland packing, nut bolts, cotton waste, insulating tape, kerosene, turpentine, jute, tefflon tape, lead lambi, soap, contents of first aid box, weather cock, refilling of oxygen cylinder, all lamps, bulbs and light fittings, pipes, specials

and CID joints, chemicals for water treatment plant at Machla Magra HWs etc. shall be arranged by the contractor whenever required. For this purpose no extra payment will be made to the contractor. Cost of all such consumable is deemed to be included in quoted cost / rates of fixed items.

ii) the contractor is to do water sampling at the tail end of each DMA for residual chlorine levels, 1 no. sample each day of different DMA.

iii) The contractor shall carry out watch & ward for all the installations in the premises as well as the pipelines along with their appurtenances.

iv) The tree plantation & gardening in the premises shall be carried out by the contractor.

v) The contractor shall maintain and upkeep the infrastructure i.e. roads, water supply, quarters, compound wall, drainage work and electrification of all the premises. General cleanliness shall be maintained. Particular attention shall be paid to toilets. Disinfectants wherever required shall be used.

vi) The contractor shall maintain telephones and intercom systems in the premises.

vii) The contractor shall maintain first aid boxes, water coolers, AC, toilets in the premises.

viii) The equipment provided for the safety of the person/public viz. Chlorine neutralization tank, breathing apparatus, weather cock shall be maintained by the contractor.

ix) If any specialized work is involved during preventive or breakdown maintenance, the same should be got it done through out side agency (i.e. proprietary nature) with prior approval of Engineer in Charge for which no extra payment will be made to contractor against labor charges.

x) The works mentioned below are to be done as follows:-

ii. Electrical power charges, i.e. payment to AVVNL :- However the electric power charges shall be deposited by the department but the contractor shall be fully responsible to check that the actual electric load does not exceed the contract demand of respective feeders. If actual electric load exceeds the contract demand of any feeder, then the penalty imposed by the Vidhyut Nigam due to excess load than the contract demand of the feeders, shall be recovered from the contractor. Contractor shall be fully responsible to know about the contract demand of all the feeders during his contract period and no excuse in this regard shall be acceptable. He shall keep complete liasioning with department authority & Vidhyut Nigam for above matter. Data regarding the contract demand of individual feeder can be obtained by contractor from the EIC immediately after the award of the work.

2.16.16. **Records & Logbooks**

The contractor shall maintain following records :

i. Preventive maintenance register

ii. Spares obtained from the department and consumption register

iii. Instructions issued by the Engineer in Charge or his representative and action taken on such instruction.

iv. Occurrence report i.e. failure of power supply, failure of any important equipment or apparatus, chlorine leakage, failure of water supply.

v. Accident report

vi. Theft report

vii. Water leakage report

viii. Pipeline burst

ix. History sheets of the equipment

x. Pipeline patrolling report

xi. Monthly report showing the equipment out of order for more than 1 week and planned maintenance activities and their fulfillment.

xii. Chemicals consumption register.

xiii. Water loss in totality from production to bulk water meter of DMA's and Consumer water meters should be maintained by calculating from concerned log books and certificate of the same shall be submitted in first week of next every month. The above described water loss, of water supply exceed the limit prescribed in Vol-I, the compensation shall be levied as per Special Condition of Contract Part "B". It is the sole responsibility of contractor to stop the water losses either due to leakages or due to theft. Reading of DMA's bulk water meter shall be taken in presence of contractor's representative.

- The contractor shall maintain following logbooks on hourly basis :

  i. Log book for 11 kV substation

  ii. Log book for raw water pumping station

  iii. Log book for clear water pumping station

  iv. Log book for water treatment plant

- The record and register shall be in form approved by Engineer-in-charge. All records and registers shall be procured by the contractor at his cost.

  i) Log books for pumping station

     (Daily, weekly and fortnightly maintenance carried out shall be entered in 'Remarks' column).

  ii) Prevention maintenance (Monthly, quarterly. Half yearly and annual)

  iii) History sheet (including repairs of equipment)

2.16.17. **Training Employer Staff**

The Contractor shall be responsible to provide practical training on all aspects of the operation, maintenance and repair of the entire system and facilities to ten personnel selected by the Department who will ultimately be responsible for the operation, maintenance and repair of the system and its facilities. For this purpose the Contractor shall orgasnize a comprehensive training programme for the Department's personnel or personnel nominated by the department, during the time of handing over of the system to the department (at the end of O&M period), and for as long thereafter as may be reasonably required to ensure that the designated personnel are adequately trained to take up their responsibilities.

The course shall include both class room lectures and on-site training in various sections. The training will be designed to enable the trainees to understand full implications of satisfactory operations and preventive maintenance The Contractor has to provide a full time team of trainers, who would be skilled in training and who will be familiar with all the normal and special operational conditions of the Work.

All costs for the Contractor's personnel and the training facilities required for the training, and any incidental training expenses, shall be included in the Contract Price. All costs of the Employer's personnel shall be borne by the Employer.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 3. Specifications for Pipe Line

3.1. General Standards

Except as otherwise specified in this technical specification, 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. The work of laying; jointing; testing and commissioning shall also be as per the relevant Indian standards. 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-in-Charge.

If any provision is prescribed in more than one Indian Standards, the specification more stringent shall be used for the work.

The use of different types of pipe material in the contract shall be in accordance to the provisions given in the "scope of work" and the principals defined therein.

3.2. Providing Pipes & Specials

3.2.1. Ductile Iron pipes

Ductile pipes to be used in the contract shall be centrifugally cast (spun) Ductile Iron Lined pipes suitable for Water and Sewage ISI Marked as per IS 8329: 2000 with internal cement mortar lining.

Ductile Iron Specials such as bends, Tees, Tapers, tail pieces etc, shall be ISI Marked as per to the IS 9523: 1980. Unless in case of abnormal site conditions warranting use of MS specials, all specials on DI pipe lone shall be of DI.

The fittings should preferably be manufactured by a manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the fitting to provide fitting which commensurate with the supplied DI pipes. The special manufacturer will however be responsible for the compatibility and quality of the products.

Supplies of rubber ring (EPDM/SBR) joint ISI Marked as per IS: 5382-1985shall be done by the Contractor and shall preferably take them from the approved vendor of the manufacturer of the pipe.

3.2.2. **Working Lengths and Tolerances**

For all purposes, the lengths of the pipes provided shall be the length as defined in IS 8329 . The pipes will be supplied in standard lengths as per the provisions in the standards (IS 8329), to which the manufacturing confirms (IS 8329). The ends shall be suitably rounded and/or chamfered ends. Any tolerance in the stipulated lengths will be as per the provision of the standards to which it has been manufactured.

The tolerance in diameter, thickness, ovality & permissible deviation from straight line shall be as per the standards to which the pipe is manufactured (IS 8329)

3.2.3. **Standards for Rubber Gasket**

Each pipe of the push on joint variety will also be supplied with a rubber EPDM gasket. The gaskets will be ISI Marked as per IS 5382:1985. Material of rubber gaskets for push-on mechanical or flanged joints shall be compatible with working pressure and temperature at which the water is to be conveyed. Rubber gaskets for use with flanged joints shall conform to IS: 638. While conveying potable water the gaskets should not deteriorate the quality of water and should not impart any taste or foul odour.

The flanged joints shall confirm to the provisions of IS 8329 . The pipe supply will also include one rubber gaskets for each flange.

3.2.4. **Inspection and Testing:**

The DI Double Flanged pipes supplied by the contractor shall be ISI Marked and will be subject to following tests as per IS 8329 for acceptance:

a) Visual and dimensional check as per IS 8329
b) Mechanical Tests as per IS 8329
c) Review of online record of Hydrostatic Test as per IS 8329 of all pipes to be supplied.
d) Any other tests required as per the provisions to which the supplied pipe confirms i.e. (IS 8329)
e) The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5382 .

The sampling method for testing shall be as per the provisions of the standards to which they are manufactured.

3.2.5. **Marking**

All pipes will be marked as per provisions of IS 8329 and subjected to the following minimum requirements:

a) Manufacturer name/ stamp with last two digits of year of manufacturing
b) USCL /PHED
c) Nominal diameter
d) Class reference
e) Manufacturing standards to which the pipe confirms (IS 8329), and BIS certification mark.
f) Mark of the pre-dispatch inspecting authority

3.2.6. **Lubricant for ductile iron pipes and specials**

3.2.6.1. **General**

This section covers the requirements for lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-in rubber ring joints

3.2.6.2. **Specifications**

The lubricant has to have the following characteristics:

- must have a paste like consistency and be ready for use
- has to adhere to wet and dry surfaces of DI pipes and rubber rings
- to be applied in hot and cold weather; ambient temperature 0 - 50 °C, temperature of exposed pipes up to 70 °C
- must be non toxic
- must be water soluble
- must not affect the properties of the drinking water carried in the pipes
- must not have an objectionable odor
- has to inhibit bacterial growth
- must not be harmful to the skin
- must have a shelf live not less than 2 years
- must be packed in 1 to 2 kg tin packing to be supplied by manufacturer of pipes.
- Manufacturer of pipes will ensure availability of test results mentioned above.

3.2.7. **Acceptance tests**

They shall be conducted in line with the provisions of the IS 9523 .

3.3. Specifications for Laying and Jointing of Pipe Line

3.3.1. General

The contractor will inspect the route along which the pipe line is proposed to be laid. The pipe alignment is duly marked on the field by demarcation pillars. However efforts shall be made by the contractor to make minor deviations from the marked alignment so as to keep the pipe alignment as straight as possible and to avoid damage of public and private properties along the alignment. The alignment of pipe line and location of specials & chambers may be changed at site in co-ordination and with prior approval of the Engineer In Charge. The final alignment on which the pipeline shall be laid shall be marked in field and got approved from the Engineer in Charge or his representative.

Where ever there is need for deviation, it should be done with the use of necessary specials or by deflection in pipe joints (limited to 75% of permissible deflection as per relevant standards). The alignment as proposed should be marked on ground with a line of white chalk and got approved from Engineer In-Charge. The position of fittings, valves, shall be as per directions of engineer-in-charge.

The quality of pipes, inner mortar lining and the quality of laying shall ensure that the considered co-efficient of friction of value (Cr=1) for DI/MS/ AC & PVC is obtained during the designed period, so that the design is validated and the designed quantities of flow can be delivered. Thus the contractor shall ensure that the conditions of pipes its lining and the laying are perfect in all respect.

Bench Marks are also required to be installed along the pipeline alignments. These shall be used for field verification of grade to which the pipe is to be laid as per the approved L-section. The demarcation and Bench Mark pillars installed by the department, if damaged or dislocated shall be reinstalled & repaired without any cost.

3.3.2. Standards

Except otherwise specified in this technical specification, the Indian Standards and Codes of Practice in their latest version, National Building code, PWD specification of the state of Rajasthan and Manual of water supply of GOI shall be adhered to for the supply, handling, laying, installation, and site testing of all material and works.

3.3.3. Alignment and the L-Sections

Pipes shall be laid along the alignment given by the department, as per enclosed L section. The gradient in which the pipe alignment is to be laid is based on the following principles:

On average, the change in slopes per km. length shall not be more than 10 in number.

The slopes provided shall be such that in existing ground level conditions, the maximum cover over the laid pipe is neither more than 1.5 m nor less than 0.6 m. The minimum cover generally should not be less than 0.9 meters. In case of PVC pipes, the pipes shall have a minimum cover of 750mm when laid under footpaths and side walks, 900 mm

when laid under roads with light traffic or under cultivated soils and 1.25 m when laid under roads with heavy traffic. When the soil has poor bearing capacity and is subject to heavy traffic, the pipes shall be laid on a concrete cradle.

3.3.4. **Tools and equipment**

The contractor has to provide required tools and equipment required for the timely, efficient and professional implementation of the work as specified in the time schedule given in the special conditions of the 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 surveyor and leveling instrument on site.

3.4. Pipe Laying below Ground

3.4.1. **Trench Excavation**

3.4.1.1. **General**

The earthwork shall be carried out as specified above. The work of trench excavation should be commensurate with laying and jointing of the pipeline. It should not be dug in advance for a length greater than 3 days ahead of work of laying and jointing of pipeline unless otherwise directed by the Engineer-in-Charge. It is proposed to ensure the following:

1. Safety precautions have to be incorporated in the work process
2. Hindrances to the public have to be minimized
3. The trench shall not be allowed to erode
4. The trench must not be filled with water
5. The trench must not be refilled before laying of the pipes
6. The bed for the laying of the pipes has to be prepared according to the L-Section immediately before laying of the pipes.

3.4.1.2. **Trench Excavation For Laying Pipeline blow ground**

The trench excavation of pipe line shall be in accordance with relevant IS and /or as per the general provisions given above. Pipe trenches shall be excavated to the lines and levels approved by the Engineer in Charge. The width of the trench at bottom between the faces of sheeting shall be such as to provide minimum 150 mm clearance on both sides of the pipe. No pipe shall be laid in a trench until the section of trench in which the pipe is to be laid has been approved by the Engineer in Charge. The walls of the trench shall be cut to stable side slopes preferably to a slope of ¼ : 1 or ½ : 1 depending on the nature of soil.

The bottom of the trench shall be trimmed and leveled to permit even bedding of the pipes. It should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation shall be made at the joints of the pipes, so that the pipe is supported along its entire length. For trench bottom with boulders or rock, sand bedding as per details detailed herein after shall be provided.

All excavated material shall be stacked in such a distance from the trench edge that it will not endanger the work or workmen and it will avoid obstructing footpaths, roads and drive ways. Hydrants under pressure, surface boxes, fire or other utility controls shall be left unobstructed and accessible during the construction work. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural water-courses shall not be obstructed.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards, as required and as specified above, shall be placed and maintained during the progress of the work and until it is safe for traffic to use the roadways. All materials and pipes which may serve as obstruction to traffic shall be enclosed by fences or barricades and shall be protected by illuminating proper lights when the visibility is poor.

As far as possible, the pipe line shall be laid below existing services, like water pipes, cables, cable ducts and drains but not below sewers, which are usually laid at greater depth. Where it is unavoidable, pipe line should be suitably protected. A minimum clearance of 150 mm shall be provided between the pipe line and such other services.

Trees, shrubbery fences, poles, and all other property and surface structures shall be protected. Tree roots shall be cut within a distance of 50 cm from pipe joints in order to prevent roots from entering them. Temporary support, adequate protection and maintenance of all under ground and surface structures, drains, sewers and other obstructions encountered in the progress of the work shall be provided. The structures, which will be disturbed, shall be restored after completion of the work.

Where water accumulates in any trench the Contractor shall maintain the trench free of water during pipe laying.

Wherever necessary to prevent caving, trench excavations in soils such as sand, gravel and sandy soil shall be adequately sheeted and braced. Where sheeting and bracing are used, the net trench width after sheeting shall not be less than that specified above. The sides of the excavation shall be adequately supported at all times and, except where described as permitted under the Contract, shall be not battered.

The Engineer in Charge in co-operation with the Contractor shall decide about the sheeting/ bracing of the trench according to the soil conditions in a particular stretch and taking into account the safety requirements of the Contractor's and Engineer- In-Charge's staff. Generally, safety measures against caving have to be provided for trenches with vertical walls if they are deeper than 2.0 m in sandy or loose formations.

3.4.1.3. **Trench excavation to commensurate with the laying progress**

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 Contractor has to ensure the following:

1. safety protections as mentioned above have to be incorporated in the work process
2. hindrances to the public have to be minimized
3. the trench must not be eroded before the pipes are laid
4. the trench must not be filled with water when the pipes are laid
5. the trench must not be refilled before laying of the pipes

The bed for the laying of the pipes has to be prepared to the pipe grades so that uniform support is assured for the full length of the pipe.

3.4.1.4. **Bedding of the pipes**

The trench bottom shall be even compact and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may injure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continuous contact between the trench and the entire pipe barrel between socket holes.

Adequate soil cushion of minimum15 cm depth shall be provided under the pipes if the strata, on which the pipes are laid, are rocky. The soil used for cushion should be free from stones, lumps and other hard objects that may injure the pipes or their coating.

3.4.2. **Laying and jointing of pipes Below Ground**

3.4.2.1. **General**

The pipe laying shall be as per the enclosed L-Sections. The pipes will be cleaned in the whole length with special care of the spigot and sockets/other ends on the inside/ outside 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 / or with permissible deflection as prescribed in the respective pipe material code between bends and/or between high and low points.

The pipes shall rest continuously on the bottom of the trench. The pipes should not rest on lumps of earth or on the joints.

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, particularly the spigot end and the socket including the groove for the rubber ring.

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 with the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer. The spigot end has to be chamfered again at the same angle as the original chamfered end. Cutting shall be perpendicular to the centre line of the pipe. In case of ductile iron pipes the cut and chamfered end shall be painted with two coats of epoxy paint. If there is no mark for the insertion depth on the spigot end of the (cut) pipe it shall be marked again according to the instructions of the manufacturer.

Where the gradient of the bed slopes is more than 15 degrees, it may be necessary to anchor pipes against their sliding downwards, by providing suitable gradient blocks and straps. Suitable cut off walls shall also be provided in these sections to protect the trench soil to be washed out during rains.

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, particularly the spigot end and the socket including the groove for the rubber ring. End caps are removed only just before laying and jointing

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.

3.4.2.2. **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 made to prevent soil, mud etc. entering the pipe.

Generally, the pipes shall be laid within two weeks from the date of their dispatch from the manufacturer/store.

The joint gaskets shall be kept in wooden boxes or their original packing and stored in cool conditions and not exposed to direct sunlight. Gaskets must not be deformed. They shall be taken out only shortly before they are needed.

3.4.2.3. **Laying and jointing of pipes**

The laying of pipes shall be as per the provisions relevant IS, however the specific references given herein shall prevail on the provisions of the standards. Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered.

On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly while the trench is back filled over the barrel of the pipe. Suitable transverse anchors shall be provided in sloping reaches as defined herein after.

The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline. The pipe shall be laid accordingly with adequate protection. The pipes in such cases shall be laid below ground with anchor blocks of suitable size and design.

The socket and spigot ends/other ends of the pipes shall be brushed and cleaned. The chamfered surface and the end of the spigot end has to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material which may damage the rubber gasket shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.

The two pipes shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade.

3.4.2.4. **Sand Bedding**

No sand bedding will be required if the pipe is to be encased by concrete in M15 of thickness 100 mm on all sides. Where the MS pipeline shall generally be laid in ordinary

sandy soil for which no extra bedding shall be provided. In such case, while doing the excavation, the bottom of the trench shall be prepared in a manner so as to match the curvature of the pipe as far as possible subtending an angle of about 120o at the centre of pipe.

Wherever the bottom of the trench is of such a nature (i.e. hard rock/decomposed rock/ hard soil/ soil having plasticity/ boulder) which is likely to cause damage to the pipe or coating or an unsuitable material is encountered which cannot support the pipe, the contractor shall excavate the trench to an additional depth below the required depth and shall refill to required level with river sand screened at source or crusher dust only. The bedding thickness shall be not less than 20 cm under the barrel of the pipes having size 400mm and above whereas it should not be less than 15cm for pipes of size up to 350mm. The complete pipe has to be covered and surrounded by the same material as used for bedding so that a total cover of 30cm above the barrel can be achieved. The excavated hard/dense soil can be refilled after bedding and covering of the pipe with the river sand screened at source or crusher dust approved by EiC. No un screened sand shall be dumped at site of pipe line.

The bedding shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming. For the purpose of the bedding under this item only screened fine sand of grain size not larger than 2mm shall be used. The sand shall be clean, uncoated and free form clay lumps, injurious amounts of dust, soft particles, organic matter, loam or other deleterious substances.

Tests specified for determining silt in sand and organic impurities as described in IS:383 shall apply. Sieved and washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the Contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures. Also where necessary, trench shall be kept dry by pumping out seepage water continuously.

3.4.3. **Transverse Anchors**

Pipes on slopes need be anchored when there the backfill around the pipe is likely to slide away or washed out due to run off in case of rains and thereby carrying the pipe with it. Generally for slopes up to 30° and in very good drained soil, carefully tamped in layers of 100 mm under and over the pipe, right up to the top of the trench will not require anchoring.

For steeper slopes, one out of every three pipe shall be held by straps fastened to vertical support anchored in concrete. Minimum two supports one at the top and other at the bottom of slope shall invariably be provided when the slope is more than those defined below.

The maximum spacing of anchors in steeply inclined pipelines should be as shown below, subjected to minimum two anchors for single stretch of gradient more than 1 in 15:

Gradient of pipeline	Spacing of transverse anchors in meters
1 in 2 and steeper	5.5
Below 1 in 2 to 1 in 4	11.0
Below 1 in 4 to 1 in 5	16.5
Below 1 in 5 to 1 in 6	22.0

3.5. **Pipe Laying above ground**

Pipe to be laid above the ground shall be laid on concrete pedestal supports. Only metallic pipes can be used in such cases. Construction of pedestals shall be as per the design approved by Engineer in Charge. Base concrete of 100 mm M10 grade shall be provide on the excavated foundation pit. Minimum one support shall be provided for each pipe. The foundation of the pedestal shall be kept at a minimum depth of 0.90 meters below ground level in sandy soils or soil mixed with boulders. In case the base is rocky strata the minimum depth of foundation shall be 0.75 meters. The construction of foundation raft and pedestal column shall be done in M25 grade of concrete. The top of the pedestal shall be provided with a suitable haunch to provide a suitable seat for the pipe. The top of pedestal support shall ensure that the pipeline is laid in grade approved by Engineer in Charge. The complete pedestal shall be finished to standard engineering practices.

Pipes shall be fixed on the support using a mild steel strap if it is not anchored at support. The thickness of the MS strap shall be not less than 6 mm and its minimum width shall be 25mm. The MS strap than shall be painted with an approved paint.

Supports, anchor and thrust blocks shall be constructed before commencing the pipe laying work in any section. The construction of the blocks shall be carried out in 3 stages. In the first stage the lower part upto 150 mm below the invert of the pipeline including concrete chairs to support it shall be constructed; in the second stage the pipeline on this part of the block shall be laid; and lastly, the remaining block around and over the pipeline shall be constructed.

The fixidity saddles/ concrete pedestals and ordinary saddles/ concrete pedestals shall be cast-at least 3 weeks before the pipeline is laid on them. After all saddles/ concrete pedestals between successive fixity points have been cast, a line plan showing the actual position thereof shall be prepared, after taking levels and measuring distances. In case of any errors in casting the pedestals, corrections shall be applied. The pipe laying work shall then start from one end and shall proceed towards the other end. The method of jointing the pipes and erecting them on previously cast R.C.C. saddles/

concrete pedestals shall be determined by the Contractor depending upon the type of plant equipment and personnel available with them.

The pipe strakes shall be assembled in position on the saddles/ concrete pedestals either by the cranes, portable gantries, shear legs or any other equipment approved by the Engineer-in-Charge. During assembly, the pipeline shall be supported on wooden sleepers and wedges, with the free end of the pipeline held in position by slings to avoid deflection.

3.5.1. **Protection against scouring of foundation:**

Providing pitching:

Wherever the pipeline pedestal or portal foundation are located near a nallah or are across a nallah, the bidder shall provide a cut-off wall upto the scour depth all around the footing/ foundation at a distance of 2 times the depth of foundations below the existing ground level. The portion between the cut-off wall and the foundation shall be filled with compacted soil and 30cm thick stone pitching shall be done with weight of stone not less than 40kg. The minimum section of cut-off wall shall be of 0.3m in width and minimum 2m in depth. The cut-off wall shall be of RR masonry in cement mortar 1:4 laid on 1:3:6 Cement concrete mix minimum 15cm thickness.

Providing longitudinal walls and cross walls:

Wherever pipe is laid on pedestal across a nallah/drain or in ravines with drain flowing across the pipe alignment, longitudinal check wall or curtain wall shall be provided on both sides of the pipe foundations. The cut-off wall on the upstream side of nallah/drain shall be taken at least up to 2m depth from the general ground level or up to the scour depth which ever is more. The downstream side of cut off wall shall be taken 2.5 m in depth. The area between two walls shall be filled with compacted soil and a gentle slope shall be provided for drainage of water in case of minor drain, but a flexible apron shall be provided for bigger nallah. The minimum width of cut off walls shall be 0.3m. The wall shall be of RR stone masonry in cement mortar 1:4 and the exposed top face shall be provided 25mm cement coping in M-15 grade or grade as per IS 456 concrete. The base course shall be of 1:3:6 mix concrete of minimum 15 cm thickness.

3.6. **Anchoring of the pipeline**

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 actual design and approval of Engineer in Charge according to 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. Nominal steel shall be provided as per the provisions of CPHEEO manual and the construction of block shall be done in M25 grade of concrete.

3.7. **Testing of the pipelines**

3.7.1. **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. 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, and other chamber).

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 if required:

1. Complete setting of the thrust blocks.
2. partial backfilling and compaction to hold the pipes in position while leaving the joints exposed for leakage control
3. opening of all intermediate valves (if any)
4. fixing the end pieces for tests and after temporarily anchoring them against the soil (not against the preceding pipe stretch)
5. at the lower end with a precision pressure gauge and the connection to the pump for establishing the test pressure
6. at the higher end with a valve for air outlet
7. 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
8. Slowly filling the pipe from the lowest point(s).
9. the water for this purpose shall be reasonably clear and free of solids and suspended matter
10. Complete removal of air through air valves along the line.
11. Closing all air valves and scour valves.
12. Slowly raising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring.
13. 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.
14. Start the test by maintaining the test pressure at the desired level by adding more make-up water; record the water added and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.
15. Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches.
16. The field testing pressures for pipelines & duration of test shall be follows:

S.No	PIPE MATERIAL	TEST PRESSURE	TEST DURATION
1.	HDPE Pipes	1.5 TIMES THE DESIGN WORKING PRESSURE	6 Hours (Pipe to be filled for 24 hours before testing)
2.	DI K-7 Pipes	12 KG/SQCM OR 1.5 TIMES WORKING PRESSURE WHICHEVER IS MORE	6 Hours (Pipe to be filled for 24 hours before testing)
3.	DI K-9 Pipes	18 KG/SQCM OR 1.5 TIMES WORKING PRESSURE WHICHEVER IS MORE	6 Hours (Pipe to be filled for 24 hours before testing)
4.	MS pipes	1.5 TIMES THE WORKING PRESSURE	6 Hours (Pipe to be filled for 24 hours before testing)

Acceptance Criteria for DI pipes shall be that the required addition of water to maintain pressure is not more than

Q = 1 liter per Km per 10 mm of pipe diameter per 30 m test pressure for 24 Hours

The acceptance criteria for HDPE pipes shall be that the test pressure should be maintained for test duration.

The sectional tests shall be accepted if the quantity of water required to be added to maintain test pressure during test duration of

No section of the pipe work shall be accepted by the Engineer in Charge until all requirements of the test have been obtained.

For MS pipes after erection at site and after the concrete anchor/ thrust blocks have been constructed. The entire pipeline shall be subjected to a hydraulic test as follows, to the required test pressure as per Clause 11 of IS: 5822.

When the field test pressure is less than 2/3 the works test pressures the period of test should be at least 24 hours. The test pressure shall be gradually raised at a rate of 0.1 N/mm^2 per minute.

If a drop in pressure occurs, the quantity of water added in order to reestablish the test pressure should be carefully measured. This should not exceed 0.1 liter/ mm of pipe diameter per km of pipeline per day for each 30 m head of pressure applied.

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline trench shall be completed.

3.7.2. **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.

3.7.3. **Pre-Commissioning & Commissioning Tests**

After successful sectional testing & leakage test, Pre-Commissioning & commissioning tests shall be performed when the work in the section is completed in all respect and the gaps / interconnections are made. These tests shall be performed as per the procedure and provisions given in Chapter 14of this document.

3.8. **SPECIFICATIONS OF MS PIPELINE WORK**

3.8.1. **Preparatory Work**

The proposals presented in this tender are based on the survey conducted by the department and available details. However for verification of the data and the whole concept, the contractor may conduct his own survey. If contractor feels to revise/change in the design of pipeline, he shall produce detailed calculations in support of changes proposed for approval to EIC. No reduction in diameters of pipelines proposed by the department shall be admissible.

3.8.2. **Topographical Surveys**

The Contractor shall propose the alignment of the proposed pipe line, fix the location and type of CD works, pipe crossing structures, thrust blocks, anchor blocks, air valves, sluice valves, butterfly valves, scour valves etc, and submit the same for the approval of the department. In addition to these, survey is also required for the construction of required structures such as realignment and grading of existing road to be crossed, for restoration of existing canals likely to be damaged during laying, to determine the scour depth of river/ nallah etc.

The surveys to be done must be able to determine the following but shall not be limited to:

- The design parameters for design of all CD structures e.g. scour depth, slope of river/nallah, high flood level discharge etc..
- To design the structures and to make working drawings of all cross drainage and pipe crossing structures along the alignment.

3.8.3. **Submissions**

The Contractor shall prepare and submit the following:

- Any change in the design of pipeline proposed by the department.
- Confirmation of department's drawings and designs.

The following general criteria must be adhered to while planning about the alignment of the pipeline:

(i) The pipeline in general shall be laid below ground.

(ii) The pipeline must be laid is a regular slope with minimum possible bends. If laying of pipe below ground is not possible to minimize close positions of bends, small stretches of pipeline may be kept above road, if circumstances so permits.

(iii) The alignment shall be kept within the approved strip of land, on the outermost edge of the ROW. The laying shall ensure minimum damage to road side construction and plantation.

(iv) If rock is encountered at a depth less than 2.5 meters for a continuous stretch of more than 100 meters, the pipeline must be laid above ground on RCC support structures, with ground clearance not less than 45cm. Alternately, pipeline may also be laid below ground but with adequate sand cushion of at least 20 cm below pipe. This shall be as per directions of Engineer in charge.

(v) Wherever the pipeline is to cross the existing oil and natural gas or water pipelines, OFC and telephone cables, etc the contractor shall take necessary permissions of the required authorities and lay the pipeline accordingly with all required structures. The department shall provide assistance to the extent possible to obtain such permission. The contractor shall be liable to all damages /claims / etc. on account of damages or accident caused due to damages of such lines.

(vi) The laying of pipes must not obstruct the flow of water in the natural drains. The pipe must cross the drains either from below the scour levels or above the high flood levels. If crossed above the bed level, appropriate structures at support and in between the nallah/drain/nallah/river must be provided in the exposed section. The structure must be protected by suitably planned river training works. If laid below ground, it must have sufficient cover without change in the existing grade of nallah/river/canal. The damaged portions of the embankment and the bed must be restored in portions the pipeline is laid below canal bed levels with proper compaction and the canal bed and sides must be lined with CC lining at least 40mm thick in at least a length of 60 meters U/S and D/S portions.

(vii) Wherever the pipeline is laid with an embankment, the embankment must not create pounding of water. If the conditions are unavoidable, suitable CD works must be provided.

3.8.4. **DESIGN OF PIPELINE**

3.8.4.1. **Detailed L-section**

The design of pipeline as per departmental concept is available with the EIC. The contractor may take these designs and check at his level and if satisfied, he must give his confirmation for doing work as per department's concept. If contractor feels to revise/change in the design of pipeline, he shall produce detailed calculations in support of changes proposed for approval to EIC. However, the contractor must compulsorily conduct fly-leveling in each section to re-confirm static level differences between two points and level of peaks, if any, to arrive at correct pumping head.

3.8.4.2. **Detailed Design**

After required survey and investigation as per above, the following designs must be got approved:

- Design & Drawings of pipe support structures
- Design & Drawings of Thrust and Anchor Blocks
- Design & Drawings of Expansion Joints
- Design of Surge Protection System from IIS Bangalore
- Design & Drawings of Valve Chambers
- Design & Drawings of all CD structures
- Design & Drawings of allied works

3.8.4.3. **Hydraulic Design for water mains**

Hydraulic design including L-sections of the pipelines are available with EIC. Contractor may take these designs/drawings for verification.

3.8.5. **MS Pipe Line Work**

3.8.5.1. **General**

This part of the specification covers the manufacturing, supply, delivery, lowering, laying, jointing, internal coating, outer coating, testing and commissioning mild steel pipes. The minimum thickness in different sections shall be as given in "Scope of Work". The preferred thickness mentioned in IS:3589-2000 will have no implication. The diameter of MS pipes mentioned anywhere in the tender documents shall mean the finished internal diameter of the pipe after accommodating the thickness of cement mortar lining as per specifications.

All the pipes, valves, MS specials and other pipe appurtenances shall be designed to withstand the maximum design pressures to which it may be subjected to under operation of the project.

3.8.5.2. **Manufacturing of MS Pipeline**

3.8.5.2.1. **Specifications**

Manufacturing of MS pipes shall be done in conformity with IS: 3589 subject to following modifications. The diameter of MS pipes mentioned anywhere in the tender documents shall mean the finished internal diameter of the pipe after accommodating the thickness of cement mortar lining as per specifications. In general MS pipes shall be manufactured as per relevant IS:1239 & IS:3589, as the case may be. However, following specifications are to be strictly followed:

- The pipe shall be fabricated out of ISI Marked steel plates or strips of fresh mild steel coils (HR coils) conforming to IS-2062, and having minimum specified tensile strength of 410 MPa. MS pipelines shall be of grade 410.
- MS PIPES including and above 500mm shall be essentially spirally welded only (longitudinally welded pipes not permissible) and should have internal cement mortar lining.
- For MS pipe line to be laid above ground, Zinc rich epoxy primer confirming to IS:14589 and Epoxy based Paint conforming to IS:14209 and as per the approved make shall be used for painting. The product shall also be marked with standard mark.
- For MS Pipes to be laid below ground level pipes shall be provided with outer tape coating.
- Inner surface of MS Pipes, witnout internal cement mortar lining shall be provided with internal coating of non toxic food grade epoxy paint.
- helical seams, butt-welded having joints with bevelled ends as per IS 3589.
- The electrode used for welding shall be ISI Marked conforming to IS 814.
- The random length of MS pipes shall be 6 meters or more without circumferential welding.
- The end of MS pipes, short pipes shall have beveled end for welding.

Manufacturing process shall ensure that –

- Base material i.e. HR coils shall be ISI Marked of required quality.
- Production equipment is well designed.
- Quality control is comprehensive.

3.8.6. **Testing**

The pipes shall be tested to the following requirements in presence of Engineer-in-Charge or his representative or a third party authorized by the Department.

a) Continuous monitoring of dia and forming.

b) Visual inspection of all pipes from inside and outside for permissible tolerances as per IS: 3589.

c) Offline ultrasonic testing of weld as per IS: 4260 during welding.

d) Radiographic testing as per IS: 4853. for 20cm length from both the ends.

e) Each pipe shall be hydraulically tested to at the manufacturer's works to a test pressure as mentioned in IS: 3589.

f) Mechanical tests of finished pipes as per IS 3589.

3.8.7. **Marking**

Each pipe shall be legibly marked as per Clause 18 of IS 3589 which shall read as USCL /PHED – O.D. – Pipe thickness – designation.

3.8.8. **Quality Assurance**

During the whole process of manufacturing, department's representative or third party shall be present to supervise the Quality Assurance process and witness the test performed.

3.8.9. **Fabrication Of MS Specials & Fittings**

3.8.9.1. **General**

Unless and otherwise mentioned in the para below, the dimensions of all MS specials and fittings (bends, tees, scour tee, reducers, enlargers, etc.) shall in general confirm to the principals of IS: 7322, using MS plate/sheet ISI Marked conforming to IS:2062. The thickness shall be adequate to sustain field test pressure but shall not be less than the thickness of the pipe at that point.

The Contractor shall submit the detailed drawing for each special to be used in the pipeline. On approval of the same by the Engineer-in-Charge, the Contractor will take up the manufacturing. All specials shall be manufactured and coated at the manufacturer's premises. In exceptional circumstances when welding in trench is unavoidable as advised by the Engineer-in-Charge, a flanged opening shall be provided for access inside the special for welding. The Contractor has to ensure the timely manufacturing of the MS specials so that they can be laid in synchronization with the pipe laying. The joints of adjacent pipe stretches have to be made with gap-pieces approved by the Engineer-in-Charge.

On completion of the manufacturing, the material shall be inspected by the Engineer-in-Charge or his representative at the manufacturer works. On approval of the latter, the coating and lining for the special will be done by the Contractor as per the specifications for coatings given in this chapter.

Tolerance for steel fittings shall confirm to the requirements of IS: 7322

3.8.9.2. **Flanged Branches**

Flanged branches shall be fabricated in accordance with the general specification and to the Engineer-in-Charge's requirement.

Flanged branches for air and scour valves shall be welded into pipe in the required position. The branch for an air valve shall be vertical and at right angle to the longitudinal axis of pipe. The invert of the branch for a scour valve shall be horizontal and at right angles to the axis of pipe and shall align with the invert of the barrel of the main pipe.

All the flanges shall be machined to standard thickness, square to the axis of the pipe.

3.8.9.3. **Bends**

Bends to provide change of alignment in pipe laying shall be manufactured to suit the site conditions. Bends of more than 45° shall not be provided. Bends shall be manufactured from tested pipes by angle cutting of the barrel or by such other standard procedure and re-welding. Bends shall be lined internally and coated externally as specified for the pipes.

a) Bends shall be fabricated taking into account the vertical and horizontal angles for each case.

b) The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.

c) Bends shall be designed with deflection angle between two segments as per provisions of IS: 7322 (amended up to date).

d) When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used.

e) Details of thrust collars anchor bolts, holding down straps, saddle plates should be furnished together with full specifications in Contractor's fabrication drawing.

3.8.9.4. **Tapers**

Tapers shall be manufactured out of steel plates and lined internally and coated externally. The tapers shall be suitable for connections to the sluice valves or flanged tailpiece on one side and to MS pipe on the other side. Stiffener rings shall be provided to afford rigidity to pipe. They shall be manufactured generally in accordance with IS: 7322.

3.8.10. **MS flanges**

Welding neck flanges confirming to BS 6392 for nominal pressure rating 1.6, 1.0 and 0.6 N/mm2 must be used in accordance to the design pressure at the place of installations.

Nominal Size of flange shall be in conformity to the equipment or pipe appurtenance with which they are to be used. The flange drilling shall conform to IS 1538 for flanges upto 1500 mm ID.

Flanges shall be provided at the end of pipes or special where sluice valves, blank flanges, tapers, etc. have to be introduced. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, so as to get the desired position of the sluice valves, etc. either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Engineer-in-Charge orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer-in-Charge, the Contractor shall provide and weld gusset stiffeners, as directed on site.

3.8.11. **Blind Flanges**

Blank flanges shall be provided at all ends left unattended for the temporary closure of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel plates, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer-in-Charge's requirements shall be provided. The thickness of the blank flanges shall be as defined in IS 6392 for the nominal size and design pressure at the place of installation, the flange drilling for all flanges upto 1500 mm ID shall conform to the provisions of IS 1538

3.8.12. **Stiffener Rings**

The Contractor shall provide stiffener rings wherever required as per approved design calculations. The Contractor shall weld the same to the pipes with one circumferential run on each side.

3.8.13. **Straps**

In general the use of straps shall not be made. Whenever, it's uses is unavoidable, approval of Engineer-in-Charge shall be taken. Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met with at site, the final connection has to be made by introducing straps to cover gaps upto 30 cm length. Straps shall also be provided as per the procedure of fixing expansion joints by the method described. Such straps shall be fabricated in the field by cutting pipes, slitting them longitudinally and slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have its inside diameter equal to the outside diameter of the pipe to be connected. A minimum lap of 8 cm on either ends of the pipe shall be kept and fillet welds shall be run both internally and externally for circumferential joint. The longitudinal joints of the collar shall be butt-welded.

All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

3.8.14. **Manholes**

For manhole installation, a fabricated tee with one side flanged must be used. The size of manhole shall not be less than 800 mm and it shall project at least 30 cm above the pipe crown.

3.8.15. **Closing or Make up sections**

Closing or make up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

3.8.16. **Test Heads**

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance shall be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing.

3.8.17. **Walkways, Stairs, Ladders, Hand Rails etc.**

Walkways, stairs, rungs, ladders, hand rails, etc. wherever necessary shall be provided or as per the directions of Engineer-in-Charge. These shall conform to well established good engineering practices.

3.8.18. **Dismantling Joint:**

All butterfly, scour valves, Bulk water meters or any other online valves etc. shall be installed between flanges with a flexible MS dismantling joint at one side. The joint must allow dismantling of the valve, meters etc. without causing stress to the joints of the attached pipes. The minimum clearance of the dismantling joint shall be five (5) cm. The pressure class of the dismantling joint shall be the same as that of the pipe. Drawings of the dismantling joint shall be submitted to the Engineer-in-Charge for approval. The Nuts and Bolts of the joint shall be galvanized. The joints shall be painted/coated as per specification given for exposed pipes.

3.8.19. **Inspection and Tests on Pipe and Fittings/Specials**

The pipe shall be tested as per provision of Clause 3.8.6 of this specification.

Each special or fittings shall be subjected to tests as per IS: 7322 before inner and outer coating. The hydraulic test pressure shall be as per IS: 3589 for specials. Dye penetration test as prescribed in IS:7322 is acceptable in lieu of hydraulic test for all specials.

The workmanship and marking on pipes must be conforming to clause 3.9.10 of this specification. All works and material under specification will be rigidly inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish material and perform work in accordance with these specifications.

The Engineer-in-Charge or the authorized inspection agency shall have free access to those parts of the plants that are concerned with the furnishing of materials of the performance of work under this specification. The bidder shall furnish the Engineer-in-Charge reasonable facilities and space without charge for inspection, testing and obtaining of any information he desires in respect of the quality of material used and the progress and manner of the work.

Sampling of pipes shall be taken as per IS 4711-1974.

Contractor shall provide and operate suitable equipment capable of conducting the specified hydraulic test pressure to the inside surfaces of the pipe and of sustaining the pressure for the required period.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 4. Specification of Valves

4.1. Scope of Work

This chapter describes the minimum requirements for the provision of valves.

Prior to the procurement of valves the Contractor shall obtain the Engineer in charge's approval for the materials to be used.

General applicable Standards to be applied to the Works under this Section shall be Indian Standards and British Standards or other approved International Standard.

4.2. General

As far as practicable all valves of the same type shall be from the same manufacturer.

Resilient seated sluice valves, butterfly valves, kinetic air valves & non return valves etc valves shall be used at following locations of water supply schemes/projects:-

1. Pumping Station(s)
2. Treatment Plant(s)
3. Supply Control Valve near OHSR/GLSR.
4. Valves of distribution system which are operated regularly for zonal supplies, and
5. Valves of all main transmission system(s) of scheme/ project.

Conventional type of valves shall continued to be used in water supply schemes / projects at all other locations than specified above.

Resilient seated valves shall have Ductile Iron body; Ductile Iron Wedge encapsulated with EPDM Rubber (of test, smell & color neutrality quality and resistant to water treatment chemicals) and Stem Sealing of NBR O-rings

Valves for pipeline installation shall comply with the relevant provisions of the appropriate BS 5163: CI Gate Valves (for potable water), BS 5151, BS EN 593: Butterfly Valves, ISO 5752 or Indian Standard referred to.

A certificate from the manufacturer's shop testing shall be provided for review by the Engineer in charge.

Before delivery to Site all working surfaces shall be thoroughly cleaned and if metal protected with grease. The initial charges of oil, grease and similar materials necessary for the correct setting to work and operation of valves and penstocks shall be provided by the Contractor. Packing must be sufficient to ensure complete protection of the fitting during transit and storage and all valves are to have their openings sealed until installation.

4.3. **Installation**

All valves, gates, operators and appurtenances shall be installed in accordance with the manufacturer's recommendations and as per the specifications laid for pipe laying, and to the locations indicated on the drawings.

The installation shall be true to alignment and rigidly supported.

As soon as installation and operating conditions permit, all valves and appurtenances shall be given a field test to be witnessed by the Engineer in charge to demonstrate that they meet all requirements and operating conditions.

Valves shall be rated for 10.0 kg / cm2 as minimum working pressure unless elsewhere defined as per the requirement or in tender document

4.4. **Flanges**

Valves shall be flanged and the flange face at right angles to the valve centerline. Backside of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Flanges shall be machined on faces and edges to IS 6392 or BS 4504 for PN 10 nominal pressure rating unless otherwise required. Flange drilling shall conform to IS 1538.

4.5. **Operation**

Depending on location the valves shall be electrically operated, or by manual hand wheel or key operation, clockwise closing unless specified otherwise by the Engineer. For

valves greater than 300 mm diameter gear operators shall be used. The direction of closing shall be clearly indicated on the hand wheel or body as appropriate.

Manual operation of valves shall be so that the torque effort required to operate the hand wheel manually, lever or chain shall not exceed 20 kg-m applied by an operator.

Valves shall be provided with operating hand wheels, caps, extension spindles and valve boxes as required. Extended valve spindles shall have spindle guides and operating caps.

For sluice valves upto 600mm diameter installed in underground chamber or otherwise not easily accessible, the Contractor shall furnish extension spindles and/or keys, or chains with extension oil cups or such similar fittings or appliances as may be required to permit easy access for proper operation, lubrication etc. Valves shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

Unless detailed otherwise all hand wheels shall have the words "open" and "close" cast in English with arrows indicating the direction of rotation. All hand wheels shall be of a solid cast type.

The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel. Valves shall be free from sharp projections. Butterfly valves shall be provided with bypass arrangement having rising spindle gate valves. Bypass may be integral with valve or connected between pipes. Minimum size of by pass for valves in main is 150 mm.

Some of the butterfly valves and sluice valves on pumping main (except scour valves on pumping main and the isolation valves for air valves) shall be electrically operated. The valves shall have arrangement for manual operation also, operated through a suitable gearbox, by hand wheel. Operation must be possible by one man against maximum design working pressure. For butterfly valves the gearbox shall be provided with self locking devices. A locking facility shall be provided for the BF valve in either the fully open, fully closed or intermediate position. Gate valves and butterfly valves shall be provided with position indicators, to show whether the valve is in the open or close position.

Scour valves shall be provided with extension spindle with supports for operation from operating level / ground level.

All valves shall be protected against corrosion. Minimum required application shall be factory applied epoxy system 250 microns thick.

Provision for indicator tags shall be made for identification / location of valves. Marking shall be either cast on the bonnet or the body and shall show the following:

- Manufacturer's name or mark
- Year of valve casting

- Size of valve
- Designation of working pressure
- Number of turns to open, with the direction of closing clearly indicated on the hand wheel or body as appropriate.
- Client's Name

Gaskets shall be of Nitrile rubber and ready made matching with respective flanges. Gaskets cut out from rubber sheets are not acceptable.

Nuts and bolts shall be of the best quality bright steel, machined on the shank and under the head and nut. Nuts and bolts shall be ISI Marked conform to IS 1363 and IS 1367, unless otherwise specified. Nuts and bolts shall be hot dip galvanized or shall be chromium plated.

4.6. **Sluice Valves**

Sluice valve shall confirm to IS 14846 and IS 780. Valves shall be compatible for underground installation without valve chamber.

Material of construction shall comply with the requirements given below:

Item	PN 1.0 Valves
Body, Dome	Ductile Iron DIN 1693-GGG40 / GGG50 Spheroid Graphite Iron IS 1865 Gr 400/12 or Gr500/7
Wedge	Ductile Iron DIN 1693-GGG40 / GGG50 Spheroid Graphite Iron IS 1865 Gr 400/12 or Gr500/7 Rubber lined with EPDM
Spindle / Stem	SS: IS 6603 04 Cr17 Ni 12 M0 2 / AISI 316
Bonnet Gasket	EPDM
Internal Fasteners	Stainless steel SS316
Nuts, bolts & washers for pipe flanges	High tensile steel Hot dip galvanized for valves in chambers. Stainless steel SS316 for buried valves

Item	PN 1.0 Valves
Coating	Internal and external with powder or liquid epoxy coating with minimum dry film thickness of 250 microns.

Valves shall be of non-rising spindle type except for the bypass valves. The spindles shall be of such lengths that when the valves are closed the bottom ends of the spindles engage fully in the spindle nuts. The spindle collars of thrust plates shall be concentric and machined, suitable for the specified test pressure. The thickness and bearing of the nut shoulders shall be adequate to resist operating thrusts. Spindles shall be greased and supplied with a cap top. Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the 'stub shaft' type, which comprise two separate shafts inserted into the valve disc hub.

The gate face rings shall be screwed into the gate or securely pegged over the full circumference. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm. Valves of 600 mm and above shall be provided with thrust bearing arrangement for ease of operation.

Valve of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N.

Valves spindles and hand wheels shall be positioned to give good access for operational personnel. Hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Valves shall have two position marked at the shut end of the scale, first one corresponding to the position of the gate tangential to the bore of the seating and the second position below the first, corresponding to the position of the gate as it sits on the seating after moving a further distance equal to the depth of the seating.

The valves shall be so designed that the gates may be removed without removing the bodies from the connecting pipe work. The gate guides shall be cast integrally with the valve bodies and be of adequate strength and of sufficient length to guide the gates throughout their full length of travel. In the fully open positions, the gates shall be fully withdrawn well clear of the stream and the spindles shall not protrude into the bores of the valves.

All Sluice valves shall be open end tested.

The Contractor shall provide test certificates for materials, strength and leakage in accordance with BS 5163 / IS 750.

4.7. **Butterfly Valves**

Butterfly valves shall be of double eccentric and resilient seated type generally as per BS EN 593, BS 5155 and IS 13095. Some of the valves will be installed in valve chambers whereas the remainder of the valves will be buried. Valves for buried conditions shall be with sealed gear box and lubricated for life time operation of minimum 30 years. Valves on transmission mains which are used for only isolation purposes shall be provided with stainless steel extension spindle / telescopic arrangement so that valves can be operated by a portable electric actuator with built in starter from ground level and without entering the chamber.

Material of construction of butterfly valves shall comply with following requirements:

S.No.	Item	Material of construction
(1)	Body	Spheroid Graphite Iron IS 1865 Gr 400/12 Ductile Iron DIN 1693-GGG 40/GGG 50
(2)	Disc	Spheroid Graphite Iron IS 1865 Gr 400/12 Ductile Iron DIN 1693-GGG 40/GGG 50
(3)	Shaft	Stainless steel BS 970 Grade 413 S19
(4)	Disc Seal Ring	EPDM
(5)	Disc Seal Retaining Ring	Stainless steel ASTM 351-CF8M
(6)	Body Seat	Stainless steel AISI 316/ Nickel weld overlay micro finished/ integral micro finished seat with valve body
(7)	Shaft Bearing	Bronze with EPDM `O' ring seal
(8)	Internal Fasteners	Stainless steel SS 316
(9)	Nuts, bolts & washers for pipe flanges	High tensile steel hot dip galvanized
(10)	Coating	Internal and external with powder or liquid food grade epoxy coating with minimum dry film thickness of 250 microns.

Butterfly valves shall be suitable for mounting in any position. The valve shall be free from induced vibrations.

Butterfly valves shall be suitable for bi-directional pressure testing with dead-tight shut off even after long period of operation of 5 years. The valves shall be of double flanged long type.

The valve seat shall be of replaceable design. When the valve is fully closed, the seal shall seat firmly. The seat surfaces shall be machined smooth to provide a long life for the seal. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

The shaft shall be stainless steel with Bronze or equivalent seal with self-lubricating bearings. Disc pins shall be stainless steel. Rings shall be bi-directional self-adjusting suitable for pressure or vacuum service. Removal and replacement of seals shall be possible without removing the operating mechanism, valve shaft and without removing the valve from the pipeline. Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel. Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The gear box shall be of worm and worm wheel design type, totally enclosed, grease filled and weather proof. The operation with gearing shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified rating. Valve and gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N. The valve disc shall have a 90 degree turn.

The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation.

It should be possible to open the valve with upstream pipe fully filled and downstream pipe empty. The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the discs by tapered stainless steel cotter pins.

Valves shall be provided with a continuous mechanical position indicator to show the position of the disc, mounted on the driven shaft end.

Rigid adjustable stop mechanism shall be provided within the gear box or elsewhere on the valve to prevent movement of the disc beyond the fully open or closed position (i.e. set points).

Valves shall be capable of closing against the maximum flow that can occur in practice. The breakaway torque under maximum differential head conditions shall be within the manufacturer's limits.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

All hand wheels shall be provided with an integral locking device to prevent operation by unauthorized persons.

4.7.1. **Diaphragm Type Flow Control/Pressure Reducing Valves:-**

In addition to (a) to (h) above -----

I. Diaphragm type flow control/pressure reducing valves shall be of single/double chambered self actuated Automatic valves i.e. operated

from line fluid pressure itself. For continuous regulation or an intermediate positioning the control valves shall be provided with two solenoid valves with facility of connecting the external signal.

II. Commands/electric signals for positioning of the control valve (for SCADA Compatibility) will be from RTU.

III. The "Diaphragm" shall be of nylon fabric reinforced (NBR) synthetic elastomer-Buna-N/EPDM. The center hold for the main valve stem must be sealed by valcunsation. The stem shall fully guided at top and bottom to avoid any deflection with a removable stem cap at the top.

IV. The diaphragm must with stand a mullins Brust Test of a minimum of 25 bar per layer of nylon fabric and shall be cycle tested 100000 times to insure longevity.

V. The internal valve component shall be accessible removable and repairable and repairable without removing the valve body from pipeline.

VI. These valves should be of self regulating type when power supply is not available.

Material of construction for Diaphragm type flow Control Valves.

Body and cover (Globe Type)	Ductile Iron ASTM A 536 or DIN 1693-GGG 40.
Diaphragm and Resilient seal disc	Flexible, non-wicking nylon fabric reinforced synthetic elastomer-Buna-N/EPDM (FDA/WRAS approved)
Seat Ring	Cast stainless steel ASTMA-A 351 GR.CF 8M/AISI-316, raised, replaceable inline & onsite.
Stem	Stainless steel AISI-316, raised replaceable inline & onsite.
Spring & Bearing bush	Stainless Steel AISI-316
Disc guide, disc retainer & Diaphragm washer	Stainless Steel AISI-304/316 Bronze & Coated steel
Seal	Synthetic Rubber-Buna-N/EPDM (FDA/WRAS approved)

Pilot	Body: Stainless Steel, AISI-304/CF8 or Brass/Bronze Elastomer: NBR.
Tubing	Stainless Steel, AISI 304/Copper
Nut-Bolts & Studs	Stainless Steel, AISI-304/ASTM A 193 B7
Solenoid Valve	Stainless Steel, AISI-316.
Throttling plug	To have the linear flow (non turbulent flow), if required, V-shaped or U-shaped throttling plug may be provided.
Coating (Both inside& outside)	Fusion Bonded Epoxy, min. 250 micron (NSF/FDA/WRAS approved)

4.8. **Air valves**

Air valves shall be installed at the high points in the systems and at regular intervals along the pipeline as indicated on the Contract Drawings. Drawing of air valve chamber & Air Valve pillars is enclosed in Vol-III. Air valves shall be installed inside RCC chamber or on RCC pillars as per site condition and direction of EiC

Material of construction of air valves shall comply with following requirements:

Body and cover	SG Iron 1865 Gr 400/12 or 500-7, Grade GGG 40/ GGG50
Float	Polycarbonate up to 50 NB / SS 304-above 50 NB
Internal Linkages	Stainless Steel 304
Seat Ring	Dexine (Nitrile Rubber) on Bronze seat

Air valves shall be of single chamber or double chamber, double orifice type and tamper proof unless otherwise directed by the Engineer in charge. A buoyant rigid float shall seal the large orifice and the chamber housing shall be designed to avoid premature closing of the valve by the air whilst being discharged. Small orifice shall discharge small air volume during operation under full internal pressures. All air valves shall be provided with isolating sluice valve and flanged end connection.

The valve shall be capable of exhausting air from pipework automatically when being filled, the air being released at a sufficiently high rate to prevent the restriction of the inflow rate. Similarly the valve shall be capable of ventilating pipework automatically when being emptied or under water hammer condition, the air inflow rate being

sufficiently high to prevent the development of a vacuum in the pipelines. The valve shall also automatically release air accumulating in pipe work during normal working conditions.

The valves shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the closed position with the float only raised by the liquid and not by a mixture of air and liquid spray. The seating shall be so designed to prevent the float sticking after a long period in the closed position.

Air valves shall thus be designed to automatically operate so that they will;

(a) positively open under internal pressure less than atmospheric pressure to admit air in bulk during pipeline draining operation;
(b) exhaust air in bulk and positively close as water, under low head, fills the body of the valve during filling operation;
(c) not blow shut under high velocity air discharge; and
(d) exhaust accumulated air under pressure while the pipe is flowing full of water.

All air valves shall be constructed so that internal working parts which may become necessary for repairs shall be readily accessible, removable, and replaceable without use of special tools and removing the valve from the line.

Valves with air intake or exhaust facilities shall have an integral protecting cover top shall be supplied to prevent dirt and debris from entering the outlet of the valve.

Valves shall have nominal diameters up to DN 200, with working pressure for air valves shall be not less than PN 16 in pump houses and PN 10 for pipe line.

The Contractor shall verify with the supplier of the valves that the valves have the capacity to sustain the pipeline test pressures prior to testing. In the event that that the valves do not sustain the pressure they shall be removed and the stub pipes from the main pipeline blanked off before pressure testing the pipeline.

The Contractor shall submit air discharge chart (for out flow and inflow of air) along with the Bid Document.

4.9. Electric Actuator

4.9.1. For butterfly valves installed in pumping stations/ For Butterfly valves acting as flow control valves (On inlet of GLSRs and CWRs)

Actuators shall be suitable for the medium, climatic, environmental and pressure conditions of the system in which they are to be fitted.

Actuators shall be provided with:

(a) AC Electric Motor.
(b) Reduction gear unit.

(c) Torque switch mechanism.
(d) Limit switch mechanism complete with set of limit switches and additional two spare sets for suitable position.
(e) Hand wheel, for manual operation.
(f) Valve position indicator.
(g) Hand-auto lever with suitable locking arrangement.
(h) 10 W single phase space heater in the switch compartment.
(i) Blinking light throughout the valve operation.
(j) Junction box for terminating power and control cables.
(k) With additional accessories for integrating with PLC system.
(l) Built in starters.

The actuator shall be suitable for operation on 415V, 3 phase, 50 Hz power supply. The motor winding insulation shall conform to class B as per relevant BS and motor shall be protected by suitable thermal overload relays. The actuator shall be capable of producing not less than 1 1/2 times the required operator torque at the required time cycle of valve operation. The transmission shaft connecting the actuator to the valve shall be provided with 2 bearings one at actuator end and one at valve end with universal couplings at suitable places. The required number of switch/contacts meet for requirements for PLC system. The electrical actuator for butterfly valves acting as flow controllers shall comprise of the additional necessary electronic card/ accessories required for generating a 4-20 ma signal and for integrating it with the PLC system.

The electric motors shall be of the squirrel cage type as per IS 325 with insulation to IS 1271 Class B. The windings shall be impregnated to render them non-hygroscopic and oil resistant. All internal metal parts shall be painted. The motor shall be rated for 15 minutes. They shall also be suitable for operating on the specified electric supply and shall satisfactorily open and close the valve under variations of electric supply specified.

Motor shall be protected by suitable overload protection device.

The reversing contactor starter and local controls shall be integral with the valve actuator. The starter shall comprise mechanically and electrically interlocked reversing contactors of appropriate rating fed from a 110 Volt control transformer. The common connection of the contactor coils at the transformer shall be grounded. HRC cartridge type primary and secondary fuses shall be provided.

Local control shall comprise pushbuttons for open, close and stop operations and a Lockable Local/Remote/off selector switch. The control schematics shall be subject to approval.

Internal wiring shall be of 650/1100 volt grade PVC insulated stranded copper conductor of minimum 1.5 sq. mm for control circuits and of minimum 4 sq.mm copper for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type. Cable entries shall be suitable for PVC insulated/ sheathed, armoured cables. A

separate terminal box shall be provided for the heater. A separate terminal box shall be provided for cabling to control circuits.

The actuator enclosure shall be fully weatherproof and hose proof to IP 67 and shall be fitted with an anti-condensation heater, which shall be switched off when the motor is running.

The torque switch mechanism shall function as follows to stop the motor on closing or opening of the valve, or upon actuation by the torque when the valve disc is restricted in its attempt to open or close.

The torque switch in the closing direction shall interrupt the control circuit if mechanical overload occurs during the closing cycle or when the valve is fully closed.

The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during the opening cycle or when the valve is fully open.

The mechanism shall facilitate adjustment of the torque at which the switches are required to operate.

Non-adjustable limit switches shall stop the motor and give indication when the disc has attained the fully open or closed position.

The adjustable limit switches shall have control rated 2A, 48 V DC for specified system interlock, at the desired value position in both the opening and closing directions.

Motor operators shall be provided with clearly visible local valve position indicators mounted on the operator assembly to give an indication whether the valve is fully open, fully closed or in an intermediate position.

Settings and emergency operation shall be possible with the use of a hand wheel. The Hand wheel shall be of stainless steel and the drive mechanically independent of the motor drive and any gearing should limit the operating torque at the hand wheel to less than 15 kg and be such as to permit emergency manual operation in a reasonable time. During electric operation the hand wheel shall not rotate.

Actuators shall be adjusted at the manufacturer's works to ensure that they provide the correct, fully, open position and fully closed position. Mechanical adjustable stops shall be provided to prevent over-travel of the valve in the open and closed positions.

The actuators shall be provided with built in starters.

4.10. **Inspection and Tests**

The following Inspection and Testing procedures shall be carried out for all the equipment as applicable:

(a) Visual Inspection.
(b) Material Certificates for all the specified material shall be furnished.

(c) Welding Qualifications.
(d) Dimension Checking.
(e) Stage Inspections (in process inspection).
(f) Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable.
(g) Operation check.
(h) Liquid penetrating tests or magnetic particle tests for all machined surfaces of pressure parts.
(i) Ultrasonic test for forging materials viz.,
(j) Plates of thickness 20mm and above for pressed / formed parts such as heads, etc.
(k) Plates, flanges and bars of thickness / diameter 40mm and above used for fabrication of pressure and load bearing members and rotating parts.
(l) Radiographic testing for all but welded parts, as per applicable codes.
(m) Hardness tests for all Hardened surfaces.

The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.

Requirement of shop tests for Valves are listed below:

(a) During testing there shall be no visible evidence of structural damage to any of the valve components.
(b) Each valve operated actuator shall be shop-operated at least three times from the fully closed to the fully opened position, and the reverse, under no-flow condition, to demonstrate that complete assembly is workable.

The tests mentioned below shall be hold points and to be witnessed by a duty authorized representative of the Employer:

The following tests shall be carried out for butterfly valves in line with IS 13095:

(a) Seat leakage test. Seat test shall be carried out in each direction and the valve shall be drop tight.
(b) Body hydrostatic test
(c) Disc strength test at body test pressure in each direction.
(d) Valve operation with and without actuator

The following tests shall be carried out for sluice valves in line with IS 14846:

(a) Seat leakage test
(b) Body hydrostatic test
(c) Valve operation

The material certificates, physical properties, heat treatments and shop test certificates of valve body, disc, wedge and shaft shall be duly approved and certified by the manufacturer and these shall be subject to review & approval by the Engineer.

Notwithstanding the above requirement for inspection and quality control, the following inspection and quality control measures shall be carried out by manufacturer:

(a) Magnetic particle tests on body and disc/door.
(b) Dye penetration tests on metal seats.
(c) Ultrasonic tests on shafts.
(d) Overload Torque Test shall be carried out on the gear boxes of the valves. The test shall be carried out by applying 1.5 times the rated torque.

4.11. **Painting**

The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting of all parts at the place of manufacture prior to packing.

Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out if necessary by washing with an approved de-watering fluid prior to surface treatment. Except where the Specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.

Protective coatings and painting shall be in line with the Standards for the particular type of valve.

4.12. **Spring Loaded Dual Plate Check Valve**

4.12.1. **General**

1. The valve shall be of flanged type suitable for mounting on a horizontal pipeline.
2. Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.
3. Dual plate check valves conform to API 594 and API 598. They shall have resilient sealing. The spring action shall optimize the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.
4. The minimum body-wall thickness shall conform to those given in Table 1B of API Standard 594.
5. The face-to-face dimensions of valves (including valves with ring-joint facings) shall conform to those mentioned in Table 2B of API Standard 594.
6. The valve body shall be furnished with a clearly visible cat, forged, machined-in, or die-stamped arrow to indicate the direction of flow through the valve.

4.12.2. **Constructional Features**

Double Flanged quick closing non slam spring loaded dual plate, generally conforming to API 594 for pressure rating as per requirement at particular section, of size equivalent to the delivery pipe, shall be provided with following material of construction:

4.12.3. **Materials of Construction**

S.N.	Particular	Required Specifications
1	Body	IS: 210, FG 260
2	Plate	ASTM A 217 Gr CA15
3	Stop Pin	AISI SS 410
4	Hinge Pin	AISI SS 410
5	Spring	AISI SS 316
6	Retainer	Carbon Steel
7	Body BRG	AISI SS 316
8	Plate BRG	AISI SS 316
9	Spring BRG	AISI SS 316
10	Seat Body	EPDM
11	Seat Plate	Integral (NO overlay)
12	Rating	As per requirement at particular section
13	Body & Plate Seat	13% Chromium Overlay

4.13. **Non-return valves**

4.13.1. **Constructional Features**

Non-return valves shall double flanged and be installed on the delivery side of the pumps, and shall be suitable for installation in a horizontal pipeline. Rapid natural closing to be non-slam by suitable design of spring return mechanism, to ensure that the valve will rapidly fully close the moment forward flow of the water ceases i.e. on pump shutdown, external counter weights will not be acceptable. To prevent excessive head loss, larger diameter non-return valves will be provided with several smaller and lighter flaps in a single bulkhead. In this case stopper to be provided for the upper door to avoid contact with shell.

4.13.2. **Materials of Construction**

Body	CI to IS Gr FG 200
Door	CI to IS Gr FG 200
Spring	Spring steel BS:970
Body ring	S S. AISI 304
Door ring	SS. AISI 304
Hinge pin	AISI 410 /431 Hardened and ground

4.14. **Specification of Flow Control/Pressure Reducing Valves.**

(a) The control valves shall be designed for flow control application for providing precise control over the flow rates/pressure range.

(b) The body of the control valve shall be designed and hydro tested for the applicable pressure rating, considering the surge pressure as per provisions in BS-EN-12266-1-2013 or any other equivalent standard.

(c) The control valves shall be designed to cause minimum head loss. The calculation method confirming to ANSI/ISA-75.01.01-2007 ((IS/IEC 60534-2-1 Mod) -2012 for flow equations for sizing of Flow Control/ Pressure Reducing valves shall be adopted. This approach allows valves from various manufacturers to be compared using the same approach, thus ensuring that the best valve is selected for the application. Fisher's Control valve Handbook, latest international Standards/ publications may also be referred in the above context.

(d) The seal at the ring should give leak tight assembly. The valve shall pass through seat leakage test as per ANSI FCI-70-2-2006 Class VI or any other equivalent standard.

(e) Flange to Flange (face to face) distance shall be as per ANSI B 16.1/EN 558-1 and Flange ends should be as per ANSI B-16.5, Class 150 and Class 300/ EN-1092-2.

(f) The material of all components of valve/internal working parts shall be corrosion resistant for chlorinated water.

(g) Wherever compability with SCADA or RTU local PLC is required, digital communication port RS 232/485 fibre optics having connectivity as per industry standard protocol should be provided (RTU shall be provided by the contractor and contractor shall also comply with the compability requirements).

(h) Provision of Battery operated option should be there in case of power failure.

A- Plunger Type Flow Control/Pressure Reducing Valve.

In addition to (a) to (h) above-

I. Plunger valves shall be provided with electrical actuators having the control facility for intermediate valve positioning by connecting external signal.
II. The electrical actuators shall be designed to provide the required torque for operations in the flow and pressure conditions of the water transfer system. Gear assembly shall be provided as necessary.
III. The flow path with flow cross section in any open position shall be rotationally symmetric. The movement of piston. Plunger by means of crank/shaft/ spindle drives shall be Axial/Linear along with irreversible worm gear box including position indicator.
IV. The general design requirements of the valve, Gear assembly and electric actuators described in the tender will be applicable to the flow control valves also.
V. A hand wheel shall be provided for plunger valves so that operations of the valve can be carried out when the power supply of valve has failed. The torque requirements at the hand when shall be such that one person can operate the valve. Hand wheel shall be positioned to give good access for operational personnel.
VI. Hand wheel shall be provided with integral locking device to prevent operation by unauthorised persons.
VII. A selector switch shall be provided on the actuator for remote/local/hand operation of the valve.

Material for Construction for Plunger type Flow Control Valve:-

Body (Globe Type)	Ductile Iron GGG40-DIN 1693 or EN-JS 1030
Plunger/Piston	Stainless steel AISI-304/Gr. 1.4301
Piston Guides	Bonze Welded Overlay/SS
Shaft Crank/Spindle	Stainless Steel AISI-420/Gr. 1.4021
Seat Ring	Stainless steel AISI-316/Bronze
Seat (O-Ring/Quad ring)	Synthetic Rubber-Buna-N/EPDM (FDA/WRAS approved)
Bearing Bush	Bronze
Bolts	SS A4
Eye bolt for lifting	Galvanised steel – 1.0401
Slotted cylinder/Strainer	Stainless steel
Coating (Both inside & outside)	Fusion Bonded Epoxy, min 250 micron (NSF/FDA/WRAS approved)

B- <u>Diaphragm Type Flow Control/Pressure Reducing Valves:-</u>

In addition to (a) to (h) above-

I. Diaphragm type flow control/pressure reducing valves shall be of single/double chambered self-actuated Automatic valves i.e. operated from line fluid pressure itself. For continuous regulation or an intermediate positioning, the control valves shall be provided with two solenoid valves with facility of connecting the external signal.

II. Commands/ electric signals for positioning of the control valve (for SCADA Compatibility) will be from RTU.

III. The "Diaphragm shall be of nylon fabric reinforced (NBR) synthetic elastomer-Buna-N/EPDM. The center hole for the main valve stem must be sealed by valcunsation. The stem shall fully guided at top and bottom to avoid any deflection with a removable stem cap at the top.

IV. The diaphragm must with stand a mullins Brust Test of a minimum of 25 bar per layer of nylon fabric and shall be cycle tested 100000 times to insure longevity.

V. The entire actuator assembly (seal disk to top cover) shall be removable from the valve as an integral unit.

VI. The internal valve component shall be accessible removable and repairable without removing the valve body form pipeline.

VII. These valves should be of self-regulating type when power supply is not available.

Material Specification for Diaphragm Type Flow Control Valves:-

Body and cover (Globe type)	Ductile Iron ASTM A 536 or DIN 1693-GGG 40
Diaphragm and resilient seal disc	Flexible, non-wicking nylon fabric reinforced synthetic elastomer-Buna-N/EPDM (FDA/WRAS approved.
Seat Ring	Cast stainless steel ASTM-A 351 GR.CF8M/AISI-316, raised replaceable inline and onsite
Stem	Stainless steel AISI-316, raised replaceable inline & onsite
Spring & Bearing bush	Stainless Steel AISI-316
Disc guide, disc retainer & diaphragm washer	Stainless Steel AISI-304/316 Bronze & coated steel
Seal	Synthetic rubber Buna-N/EPDM (FDA/WRAS/approved)
Pilot	Body: Stainless Steel AISI-304/CF8 or Brass/ Bronze Elastomer: NBR
Tubing	Stainless steel, AISI 304/Copper
Nut-Bolts & studs	Stainless steel, AISI 304/ASTM A 193 B 7
Solenoid Valve	Stainless Steel AISI-316
Throttling Plug	To have the linear flow (non-turbulent flow), if required, V-shaped or U-shaped throttling plug may be provided.

Coating (Both inside and outside)	Fusion Bonded Epoxy, min. 250 micron, (NSF/ FDA/ WRAS approved)

4.15. Specifications for Expansion Bellows

	Particular	Required Specifications
1	Make	Any make as proposed by bidder subject to approval of QAP
2	Bellows	SA 240 Gr 304
3	Weldend	IS 2062 Gr B
4	Internal Sleeve	SA 240 Gr 304
5	Flanges	IS 2062 Gr B
6	Limit Rods	C.S. IS1367 Cl 4.6
7	Gasket	CAF
8	Nuts & Lock Nuts	C.S. IS1367 Cl 4.0
9	Lugs	IS 2062 Gr B
9	Shipping	M.S. Weldable
	Collar	SA 240 Gr 304
	Design Temp	50 deg
	Axial Extension	5 mm
	Axial Compression	15mm

4.16. Nut, Bolts, Washers

The jointing material such as nuts, bolts, washers, pig lead, rubber packing, etc. shall be provided by the Contractor.

Nuts and bolts shall be of the best quality bright steel, machined on the shank and under the head and nut. Studs, bolts and nuts shall be galvanized. Bolts shall be of accurate length so that only one thread shall show through the nut in the fully tightened conditions. Nuts and bolts shall be ISI Marked conforming to IS 1363 and IS 1367.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary.

Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel bearing stainless steel.

The Contractor shall supply all holding down, alignment leveling bolts complete with anchorages, nuts washers and packing required to fix the plant to its foundations, bed plates, frames and other structural parts.

The Contractor shall procure and keep at site, reasonable excess quantities to cover wastage of those materials which will be normally subject to waste during erection, commissioning and setting to work.

Throughout erection, the valves shall be supported properly on wooden sleepers, etc. and shall be concreted immediately thereafter, as directed. Before the valves are actually fixed, they shall be cleaned and greased and it should be seen that all parts are in perfect working condition. In the case of air valves, the Contractor shall take special care of the Dexine joints and the ebonite and /or vulcanite balls until they are fixed in position. They shall be kept immersed in water in suitable containers.

4.17. **Gaskets &Packings**

These shall be as per clause 4.8.2 Gaskets shall be of Nitrile rubber and ready made matching with respective flanges. Gasket cut-out from rubber sheets are not acceptable.

4.18. **Gear Box for Valves**

Gear box must be self locking type, with a continuous indicator. Travelling nut and screw type of gear boxes are not acceptable

The gear box of quadrant type or traveling nut type must conform to the provisions of AWWA C-504. The rated torque capability of each operator shall be sufficient to seat, unseat and rigidly hold in any intermediate position the valve disc it controls under the operating conditions specified. Operating torque must be as per requirements given in clause 4.10

The operator must essentially be of self locking type with or without additional spur gear arrangement to ensure that the effort on hand wheel is limited to the pull specified.

All valve operators shall be equipped with adjustable mechanical stop-limiting devices to prevent over-travel of the valve disc in the open and closed positions. Either end of the worm shaft must be provided with needle roller bearing to take on the lateral thrust.

The housing for the gearing must be enclosed and sealed in such a way that there is no leakage of oil / grease even after long period of un-use and there is no ingress of rain water. Operator for valves, which are likely to be submerged in water for long period during the rainy season, must be water tight.

The hand wheels may be provided with extension for easy grip. The hand wheels must have a provision for locking with a chain and pad lock. All operators when fitted to the valve shaft must ensure clock wise closing and this must be indicated on the housing. A mechanical indicator is to be provided to show disc travel and end of travel.

4.19. **Material of Construction :**

Housing and Cover	:	CI Gr 25/SG Gr 500-7/CS Gr WCB
Quadrant	:	SG Gr 500-7
Spur Gears	:	EN-8 with hardened pinions of EN-19
Worm	:	EN-19, hardened
Bearings	:	FAG/SKF/Equivalent
"O" rings	:	Nitrile rubber
Hand wheel	:	Steel / SG Iron

Chief Executive Officer
Udaipur Smart City Limited

Chapter 5. Specifications For Treatment Plant

5.1. General

5.1.1. Plant and Process Design Parameters

The plant shall be designed, constructed and installed taking into account site ambient conditions, local conditions & location. The plant shall be designed for the ambient temperature with the bidder making due allowances in his design for the increased temperatures experienced by Clariflocculators and filter plant exposed to direct sunlight.

The WTP shall be hydraulically designed for continuous operation to treat 23.71 **Error! Bookmark not defined.**MLD raw water in 22 hours, to specified quality standards. The loss of water in terms of sludge bleed from the clarifiers and filter backwash shall be kept to the minimum and not exceeding 1% of the raw water input. Except otherwise mentioned, the entire plant shall be hydraulically designed for an overload of 33%.

5.2. Raw Water Quality

The treatment plant shall be designed to treat water having the raw water quality of Pichhola Lake as detailed below.

The characteristics of raw waters samples taken from Pichhola Lake are furnished in Table 1. The bidder shall however ascertain the raw water quality before bidding and also carry out analysis of any other parameters required by him, which are not furnished in the raw water analysis supplied in Table 1. The bidder shall, in addition, carry out the treatability tests he considers necessary to deliver the guaranteed water quantity & quality. The bidder, while designing T.P., shall provide for treating raw water having maximum turbidity upto 1 to 500NTU. The quality of water as observed on is as follows

Table 1 : Quality of Raw Water in Pichhola Lake

								Water quality(mg/L)							
lab no.	Town	Raw Water Source	source	Source & location	**pH**	**Turbidity**	**Alaklinity**	**Total Hardness**	**Calcium Hardness**	**Chloride**	**Nitrate**	**TDS**	**Fluoride**	**IRON**	Date Of reciept
						NTU			(as CaCO3)	(as Cl)	(as NO3)		(as F)		
204	Udaipur	Pichhola Lake	CWR	Doodhtalai RGF	7.7	0.4	120	150	60	60	3	360	0.2		2017.6.1
206	Udaipur	Pichhola Lake	Raw Water	Patel Circle RGF	8	1.3	130	140	60	60	3	300	0.2		2017.6.6
207	Udaipur	Pichhola Lake	Filter Water	Patel Circle RGF	7.7	0.4	120	150	60	60	3	360	0.2		2017.6.6
236	Udaipur	Pichhola Lake	Raw water	Gulab Bagh RGF	8	1.2	140	150	60	60	3	240	0.2		2017.6.12
237	Udaipur	Pichhola Lake	Filter Water	Gulab Bagh RGF	7.6	0.4	130	160	60	60	3	300	0.2		2017.6.12
241	Udaipur	Pichhola Lake	Raw water	Doodh Talai RGF	8	1.2	140	150	60	60	3	300	0.2		2017.6.12
242	Udaipur	Pichhola Lake	CWR	Doodh Talai RGF	7.7	0.3	130	160	60	60	3	360	0.2		2017.6.12
244	Udaipur	Pichhola Lake	Raw water	Patel Circle RGF	8	1.2	140	150	60	60	3	300	0.2		2017.6.13
245	Udaipur	Pichhola Lake	Filter Water	Patel Circle RGF	7.6	0.5	130	160	60	60	3	360	0.2		2017.6.13
282	Udaipur	Pichhola Lake	Raw Water	Patel Circle RGF	8.1	1.2	140	150	60	60	3	300	0.2		2017.6.20
283	Udaipur	Pichhola Lake	Filter Water	Patel Circle RGF	7.7	0.6	130	150	60	60	3	300	0.2		2017.6.20
304	Udaipur	Pichhola Lake	Raw Water	Patel Circle RGF	8	1.2	130	150	60	60	2	300	0.3		2017.6.27
305	Udaipur	Pichhola Lake	Filter Water	Patel Circle RGF	7.7	0.3	120	150	60	60	2	300	0.3		2017.6.27
306	Udaipur	Pichhola Lake	Raw water	Doodh Talai RGF	8	1.3	130	150	60	60	2	300	0.3		2017.6.28
307	Udaipur	Pichhola Lake	Filter Water	Doodh Talai RGF	7.6	0.4	120	150	60	60	2	300	0.3		2017.6.28

Note: All concentration in mg/l, Turbidity in NTU

5.2.1. **Process guarantees**

Apart from the quality of the treated water and the indicated water levels at the output and input of the plant the Contractor has to guarantee the following process performances:

Table 2: Quality of Treated Water Process guarantees

Turbidity of the effluent of the Tube Settlers. Pre-chlorination & alum dosing to be done by contractor under this contract including supply and use of Alum & liquid chlorine as per requirements to achieve specified results. :	not more than 15 NTU
suspended solids in the effluent of the Tube Settlers :	not more than 8 mg/l

suspended solids in the effluent of the Tube Settlers	:	not more than 8 mg/l
total aluminium in the effluent of the Tube Settlers	:	not more than 0.5 mg/l
Minimum free available chlorine residual content in the treated water, after 10 minutes contact. Post-chlorination to be done by contractor under this contract including supply and use of liquid chlorine as per requirements to achieve specified results.	:	Min 3.00 mg/l
minimum filter run period at any time of the year between successive backwashing	:	24 hours
minimum filter run during 95 % of the year between successive backwashing	:	36 hours
maximum water losses (filter backwash, de-sludging, etc.) in the treatment plant during a period of any 7 consecutive days , using the recycling reservoirs	:	1 % of the raw water input

Table 3: Treated Water Quality Parameters

Parameters with Units	Required Output Standard	Permissible Standards
Turbidity (N.T.U.)	< 1.0	2.5
Colour (Units on Platinum Cobalt Scale) TCU	5.00	25
Taste and Odour	Unobjectionable	Unobjectionable
pH	7-8.5	6.5-9.2
Faecal coliforms number/100ml	Not detectable in 100ml Sample	Not detectable in 100ml Sample
Coliform organisms number/100ml	Not detectable in 100ml Sample	Not detectable in 100ml Sample
Residual Aluminium mg/l, Al	< 0.1	0.1

Parameters with Units	Required Output Standard	Permissible Standards
Minimum free available chlorine in chlorine contact tank	Min 3 mg/lt	-

If any of the quality and process parameters cannot be achieved during trial run, the Contractor shall at his expenses carry out all necessary modifications to the civil structures, the mechanical, hydraulic, electrical and other components of the plant, or modify the operation procedures and alter the chemicals/ Chemical dosing parameters in order to achieve the required performance of the plant.

5.3. **Preparatory Work**

The details of the morphology are to be checked by the Contractor before the final layout of the units of the plant. He has to use the land earmarked to accommodate for the sitting of all the units of the final capacity treatment plant. Whenever there is an abrupt change in levels the sides/boundaries of the land allotted shall be neatly dressed with side slopes 1V:3H. Surplus earth, if any, shall be disposed of as per directions of the Engineer-in-Charge

The Contractor shall construct a benchmark at a suitable location within the campus and transfer level from GTS benchmark approved by the Engineer-in-Charge. All levels shall be deemed to refer to that benchmark. The Contractor may establish other secondary benchmarks on the site.

5.3.1. **Soil Investigation**

The Contractor in co-ordination with the Engineer in Charge has to determine at each location of a building or water retaining structure the soil characteristics (safe bearing capacity, angle of friction, cohesion) in order to calculate the dimensions of the foundations, where the foundation of structures is to be laid on soil.

In case foundation is to be laid on firm rock the contractor shall consider a maximum safe bearing capacity of 18 MT/sqm in design of structural members.

Wherever it is likely that the water table shall raise up to the footings of the structures, it will be essential to assess the potential of changes in water table, erosion and exposure of foundations and the stability of the soil with view to the lateral resistance to be taken into account.

The soil conditions have to be analyzed for all-important structures: ground level reservoirs, filters, settling tanks, multi-floor buildings. In case of soil, the required soil analyses are:

a) Penetration tests

- Standard penetration test to a depth corresponding to at least 1.5 times the width of the building/foundation; at least 3 tests per building/reservoir; distance between the penetration points less than 20 m

b) Plate load tests:

- to assess soil bearing capacity at the foundation level (Plate test)

- to take samples for laboratory analyses

c) Pile Test

As per IS 2911 for each structure proposed with pile foundation.

d) laboratory analyses for different burrow areas

- granulometry

- Liquid and plastic limit

- cohesion

- angle of friction

Chemical contents, dry density, optimum moisture content, permeability, maximum dry density at OMC and degree of compaction required for achieving maximum dry density through proctor test, Tri-axial tests and other recognized tests from a recognized laboratory

Any other tests required to determine the design parameters of the structures/embankments

At least 3 test pits shall be made for each site of a building/tank/structure., preferably after having fixed the location of the building. The distance should be less than 20 m.

If the standard penetration tests give a sufficiently clear picture of the soil bearing capacity the number of test pits can be reduced.

In addition the following soil data have to be provided from the test pits:

- composition and classification of the soil (sand, clay, silt, organic matter etc, soft, medium, hard, decomposed rock, rock etc.) with view to:

- excavation

- need to support walls of trenches

- compacting
- permanent or temporary groundwater (water logging)
- hard pans below the sand (depth, thickness, type of layer)
- clay lenses

Cube Crushing Tests for Rocks

For the areas where the foundation is to be laid on rock, samples of rocks shall be taken for preparation of cubes. The cubes will then be tested for their crushing strength for the weakest section (i.e. by application of load along the bedding angle) and safe bearing capacity shall be determined using suitable factor of safety. At least 3 samples for a site shall be tested.

The results of the survey, the sampling, the laboratory analyses and the calculations have to be presented in a report in three copies to the Engineer in Charge. The execution of the foundations shall be started only after approval of the Engineer in Charge. The contractor however will be responsible for design of the structures based on these investigations.

Along with the excavation for the buildings and reservoirs the Contractor has to assess / complete the type of soil, the strata, the level of groundwater and other indicators important for payment. He has to establish soil profiles and submit these to the Engineer in Charge for approval.

5.3.2. **Detailed design**

The bidder shall design Water Treatment Plant on conventional basis i.e. Clari-flocculators or flocculation units or Tube Settlers (due to space constraint) followed by high rate tube settlers in hopper bottom clarifiers, constant rate, rising head, split flow filters; the filter beds open to sky. This process is fixed and cannot be changed. The various design parameters indicated in the following paras and elsewhere cover only the main parameters. All the detailed parameters laid down in the Manual of Water Supply and Water Treatment or the relevant IS however shall be applicable. The only deviations permitted from those contained in the Manual or IS Standards are those contained in these specifications. Based on his process design, approved by department, the Contractor has to prepare the final detailed design, according to the latest Indian Standards (published up to date of submission of bid), the Manual on Water Supply and Treatment, the tender documents and the instructions of the Engineer-in-Charge.

The detailed design of the entire treatment plant, architectural, hydraulic and structural design has to be prepared in close co-ordination with the Engineer-in-Charge. The layout and hydraulic diagrams shall be prepared for the designed inflow which will be approved by Engineer-in-Charge. Placement of order, manufacturing or construction

can start only after the approval of all the related designs and drawings. The procedures for the approval shall have to be followed as prescribed in the Special Conditions of Contract.

5.4. Treatment Works - Plant Specifications

The intention is to automate all the treatment plant operations such as flow control, distribution of flows to various units of the treatment plant, filter back wash operations, chemical and chlorine dosing etc. Subsequently the entire operations of the treatment plant shall be through SCADA with master control station at this treatment plant. All the equipment and processes shall thus be compatible with the above Control Philosophy.

The Contractor has to propose the equipment of standard and reputed manufacturers for approval of the Engineer-in-Charge having the ISI or other relevant standards Mark/conformance certificate. The Engineer-in-Charge shall examine the proposal on the basis of the submitted documents and shall approve it or refuse it if it does not correspond to the highest quality standards and to the specifications.

This chapter of the specifications deals with all treatment plant related works and equipment. Detailed specifications for pipes and appurtenances, mechanical equipment, electrical equipment, instrumentation and control systems and civil works are also presented in the different chapters of this volume which have to be read in conjunction with this chapter. The treatment plant along with its units/components shall be designed for an input turbidity of 500 NTU

5.4.1. Cascade aerator

The Cascade Aerator shall be reinforced cement concrete structure. A total of 5 Nos of steps are to be provided in the aerator with 200 mm rise of each step. A peripheral launder of minimum 600 mm width shall be provided. The free board of the launder is to be 300 mm. The top of Cascade aerator shall no be above R.L. 634.375 m. **Benchmark level is road level at Dudh Talai Pump House at R.L. 598.05 m.**

5.4.2. Receiving (Inlet) chamber

The receiving chamber shall be a reinforced cement concrete structure. The pipe from the raw water pumping main shall be connected at a flange of a pipe, which shall be cast in the wall at the lower part of the chamber (puddle collar). The providing and fixing of the puddle collar is part of the WTP Unit. The top of the chamber shall be accessible by the general walkway along the measuring channel. The receiving chamber shall be connected to the drainage system by means of a wall duct and a valve minimum DN 100mm. A mild steel ladder shall be provided in the chamber to access the bottom. The capacity of the receiving chambers shall be in accordance to the inflow of 23.71 MLD and the required 33% overloading.

The alum/primary coagulant and lime solutions (if/when required) shall be injected into this chamber with feeder pipes. The outlets of feeder pipes shall be placed near the raw water inlet pipe to ensure a thorough mixing.

The chlorine solution (for pre-chlorination) shall be injected by bottom mounted diffuser disks or pipes. The diffuser system and baffle walls installed in the chamber shall be designed to guide the incoming water and to ensure a complete diffusion of the chlorine solution before it leaves the chamber. The chlorine solution-feeding unit must be detachable for easy maintenance without interrupting the flow of the raw water into the measuring channel. There shall be no smell of chlorine at a distance of 10 m from the chamber.

All inner surfaces of the inlet chamber shall be coated with epoxy paint of approved shade, resistive to the aggressive water to avoid corrosion in the acidic environment.

Parameters:

Design Flow: Normal ; Corresponding to 23.71 MLD raw water

Top W.L.	To be arrived at by bidders
Free Board	30 cm.

5.4.3. **Raw water inlet pipe and Bulk flow meter**

The raw water will be measured through electromagnetic bulk flow meter integrated on the inlet pipe. The local display unit for the electromagnetic flow meter shall be provided near its installation. Connectivity of this electromagnetic meter shall also be made with the Plant communication data bus using suitable I/O port and communication cables for connectivity with I&C PANEL.

The contractor shall provide a table/ chart with the calibrated values of the inlet pipe discharge. The inlet pipe should be designed as per the required flow with minimum head losses.

5.4.4. **Mixing chambers – Flash Mixer**

The mixing chambers shall be of reinforced concrete. The inlet to the mixing chambers shall be provided with electrically operated wall gates. The freeboard shall be at least 30 cm. A mild steel ladder shall be provided in the chamber to access the bottom.

Mixing chamber shall be equipped with an impeller type, high-speed mixer. The driving motor of suitable capacity and other accessories shall be totally enclosed but easily accessible for maintenance. The shaft with the impeller shall be freely suspended from the driving gear mounted on a platform on top of the reservoir or shall be supported on a center pier with pedestal and bush. The shaft of the mixer and the impeller shall be of stainless steel-316.

The outlet of the chamber shall lead directly to the respective Flocculation zone. The pipes shall be flanged MS/DI pipes. The top of the mixing unit is to be made accessible

by the general walkway along the measuring channel. The chamber shall be connected to the drainage system by means of a wall duct and a sluice valve of minimum DN 100.

Parameters:

(A) Mixing Chamber

-Detention Period	30 to 60 secs.
Sluice Gates	Adequately sized

12.1.1 Clariflocculators / Clarifiers

The general requirement of the alternatives for flocculation and clarification shall be as follows:

Clarifiers Equipped with High Rate Tube Settlers

Clarifiers equipped with high rate tube settlers shall also be acceptable. The flocculation units in such cases shall be separate units immediately succeeding and or integral with rapid mixing units. The flocculation units shall have the parameters as defined below.

The Tube Settlers/ clarifiers shall be of reinforced cement concrete hopper bottom with central feed and automatic sludge bleeding arrangements capable of being set at different rates with a provision of manual override. The minimum net detention time at maximum hydraulic flow rate shall not be less than 15 minutes.

The tube settlers shall be preferably inclined of Chevron / Hexagonal shape and manufactured out of virgin plastic media material and shall be certified to be non-leaching, non-corrodible, non-biodegradable and UV resistant.

The adopted system parameters shall be in conformity with any of the clarifiers based on this technology for a water treatment plant of at least 8 MLD capacity, which has been successfully working for at least the last three years.

General specification for alternative of conventional clariflocculator

The circular reinforced cement concrete clariflocculator shall have a central area for coagulation and flocculation and outer area for settling. They shall preferably have a peripheral weir with vertically adjustable stainless steel weir blades for the uniform surface withdrawal of the clarified water. The blades shall be fixed with stainless steel anchors, nuts and washers. The flocculation zone and the sedimentation zone shall be separated by a circular isolation wall. All inlets, outlets passages of water shall be designed and arranged for a steady and uniform flow without undue turbulence to avoid disintegration of flocks. The freeboard shall be at least 30 cm.

A bridge with peripheral on-board drive with steel wheels traveling on the steel billets on theperipheral wall will be provided with:

- Central platform for the installation of minimum (2 Nos.) independently driven stirrers and their drives and for the local control Panel;
- Minimum (2 Nos. independently driven) paddle stirrers/agitator's for slow mixing of the incoming raw water in the central unit;

- a radial scraper system with bottom scraper blades, suspended on the bridge.

The hydraulic equipment is:

- the inlet pipe from the mixing chamber feeding into the central flocculation part;
- sludge bleeding outlet pipe with an electrically driven valve for intermittent operation according to an adjustable timer;
- discharge pipe from the sludge outlet and the drainage outlet to the drainage system.
- a discharge channel from the peripheral collecting channel to the main channel leading to the filters.
- A drain valve if the sludge bleeding valve is not provided at the floor level of the flocculator

The mechanical and electrical equipment is:

- incoming cable with slip ring contacts for the on-board power supply and the supply of all flocculator and bridge drive motors;
- on-board Panel for all operations of the unit with connections to the main control room and I&C PANEL system for indication of the status of the unit components and operation of motors;
- adjustable gear drives for the flocculator stirrers;
- suitable gear constant speed drive for the bridge;
- emergency stop buttons at the center and at the outer side of the bridge;
- lighting.

The access to the bridge shall be possible from the peripheral walkway along the outer wall of the clariflocculator of width not less than 90 cm with a MS railing.

The operation of the bridge and the clariflocculator units shall be as follows:

- automatic start with the start of the raw water flow
- automatic stop 10 minutes after the stop of the raw water flow
- manual start and stop from the local control Panel.

The sludge bleeding valve shall be of electrically operated type. The frequency and discharge of the sludge valve will be adjusted manually according to the raw water inflow. The operation of valve will be controlled with the information from the flow measurement flume in the raw water channel. The sludge valve shall also have a provision of being operated manually.

a) Rotating scraper bridge and accessories

The scrapers, flocculator blades and the rotating bridge supplied by the Contractor shall generally be manufactured in steel, painted and protected with epoxy primer and paint of approved shade. All handrails shall be galvanised.

b) Rotating bridge structure

The rotating bridge structure shall incorporate a walkway having a minimum effective width of 90 cm, which shall be, surfaced with MS chequered plates, painted black. The bridge shall be designed to take its own dead weight together with uniformly distributed loading of 250 kg/m² over the full span and width of the walkway bridge and a moving point load of 500 kg. Maximum deflection of the bridge under the specified loading shall not exceed 1/360th of the span. The positive camber shall be kept initially to compensate for the maximum deflection under dead weight and superimposed loads.

The bridge shall be so braced as to limit lateral deflection to less than 80 mm measured at mid span under a full load condition.

The central part of the bridge shall be large enough for the installation of the flocculator systems and the control Panel.

The bridge shall have hand railing to both sides forming an enclosure at the centre in between. The finished height of the railing shall be 1 m above the walkway. Toe guards shall be provided and secured around the bridge walkway, which shall not be less than 100 mm high and 5 mm thick.

c) Bridge support and end carriage

The bridge structure shall be supported at the centre of the clari-flocculator by means of cast iron bearing assembly of the slewing ring type and incorporating trunnion type mountings to accommodate vertical undulations of the traction wheels at the peripheral wall of the tank. The central bearing assembly shall be adequately lubricated and all grease points shall be extended to a battery plate mounted at the convenient point above the walkway. Oil fill and drain points, where applicable shall be extended to provide a convenient access for filling and draining the system. Catch drains shall be provided under all oil and grease points to prevent spillage from reaching the water surface.

The wheel carriage assembly shall be suitably proportioned to provide adequate stability to the rotating bridge structure, whilst providing the suitable base for the motors, gearbox, driving and idling wheels, shafts and bearings. The wheels shall be plain without flanges. They shall travel on steel billets. The tolerance of the wheels shall be such that a de-railing cannot occur due to some misalignment. The size and design of wheels and carriage shall be calculated to transmit optimum tractive effort relative to the proportions of the scraper without producing wheel spin when the wheel path is subject to the climatic conditions.

d) Drive

The bridge drive shall comprise of either (a) motor with reduction gear a chain sprocket or (b) a geared motor. The assembly shall be rigidly mounted and shall be adequately rated for continuous service in a water treatment works environment.

All lubrication points and all necessary provisions shall be made for routine maintenance and for prevention of oil and grease spillage. A deflector shall be provided and fitted to the leading edge of the driving carriage. It shall be angled at 45° and arranged to be adjustable to within 3 mm of the perimeter rail such that material coming in the way of free passage of the wheel shall be deflected.

e) Blades and fixtures

Scrapers shall be suspended and arranged to give continuous and progressive scraping of the entire floor of the clariflocculator and the swept area of the successive blades shall overlap. The configuration of blades shall be designed to carry sludge and deposited suspended solids from the periphery of the tank and deposit it efficiently in the withdrawal hopper/sludge pocket.

The number and length of individual blades shall be designed by the Contractor, but the depth shall not be less than 300 mm and the thickness not less than 6 mm. Renewable fabric reinforced rubber wearing strips of cross section not less than 12 mm x 100 mm shall be fitted to each blade to provide a continuous contact surface which is adjustable for wear. The material shall have hardness not greater than 40 and be manufactured from well-proven compound.

Backing strips shall be fitted to give support to the fixing of the rubber wearing strips and the assembly shall be secured by means of stainless steel nuts, bolts and washers. Appropriate washers shall be fitted beneath all bolt heads and nuts.

The top connections shall permit the blades to follow slight undulations in the tank floor. The bottom connections shall allow the blades to maintain contact with the floor throughout its length, while accommodating slight variations in the radial plane of the tank floor.

f) Flocculation zone

The central driven flocculators shall consist of MS flocculator paddles, fixed to a SS shaft with guide bearings and guide brackets suitable for under water use. The paddle area shall be at least 10% of the sectional area of the flocculator zone. The drive mechanism shall consist of in a 440 V, 50 Hz, 3 phase motors with reduction gear of suitable ratio.

g) Motors, starters and control

The electrical supply to bridge or flocculator driving motors shall be taken through a multi-ring and slip-ring collector unit mounted in a fully water proof enclosure. The unit shall be fitted at the centre of rotation of each bridge and shall be complete with all necessary support bracket, anti-rotation device. A suitable means of lubrication shall be provided.

The slip ring assembly shall be mounted above the top level of the tank walls. Sufficient rings shall be included to cover the motor supply and any ancillary circuits. Bridge drive and flocculator motors shall be of squirrel cage type, protected and shall be rated 25% above design duty.

All cables shall be connected to a termination box at the wall of the clariflocculator. From there cables are to be connected to the main control Panel

The bridge drive and the flocculators shall be controlled from an outdoor Panel installed in the central part of the bridge. The drive status indicating lamps shall be provided

on the Main Control Panel. Necessary connections shall be made for operation of bridge drive and flocculators from I & C PANEL control room.

h) Parameters:

Flow Capacities:	
Designed	23.47 MLD Treated Water
Over loading (hydraulic)	33%
Flocculation Zone :	
Detention Time	20-30 min.
Velocity Gradient	40 to 60
Tip Speed	less than 1 m/s
Paddle Area*	10 to 25% of vertical section
Tube Settler:	
Sedimentation Velocity	0.8-1 m/hr
Depth of Tube Settler Pack	1 m
Angle of Inclination of Tubes	45-60 degrees
No. of Hoppers per Tank	1 Nos.
Clari-flocculator (alternative option) :	
Detention time	2 to 2.5 hrs.
Surface Loading	<1.67 cum./sq.m./ hr.
Weir Loading	< 12.50 cum./m./hr.
Depth at outer edge (side water depth)	Minimum 3.0 m
Scraper Bridge :	
Time for one rev.	30 to 60 min.

* The edges of the paddles shall be at least 30 cm away from any other structures offlocculator.

5.4.5. **Bypass of the flocculator(s); collecting channel; overflow**

The flocculation zone shall be bypassed by connecting the inlet channel after inlet pipe directly to the collecting channel from flocculation zone, leading to the filters. The bypass can be used during periods of good raw water quality with minimum of turbidity and suspended solids for direct loading of the filters.

An overflow shall be provided at the collecting channel to avoid uncontrolled flooding of the plant. Free board of the collecting channel should be 30 cm and shall be suitably connected through pipe/ channel to the general drainage system of the campus.

5.4.6. **Sludge Withdrawal**

The underflow from the flocculator(s)/ Tube Settler(s) shall be led through a CI/DI pipe for suitable disposal in environmental friendly way.

5.4.7. **Rapid sand filters**

Filter beds and inlet channels

The filter beds shall be supplied, clarified or by-passed raw water the main channel / secondary channel coming from the Tube Settlers/ flocculator(s). The filters shall be of the constant flow and rising water level type (split flow). All filters shall be identical in internal dimensions. The top level of the filters shall be same as that of the feeding channels to avoid overflow in the filter area.

A rectangular sharp edged weir with gate / buttery fly valve of area double than that of designed gate size, shall be provided at the filter inlet to control the flow to the filters. The weirs / valves shall be adjusted in a manner that all filters in operation receive the same flow taking into account the hydraulic conditions of the common feeder channel and fully opened gates. The tolerance shall not exceed +/- 5 %. The gate / valve shall be used for the isolation of a filter in case of backwash or maintenance. Gate / valve shall be electrically operated from the filter control consoles / I&C Panel and shall also have manual operation features.

The water level on the filter bed during filtration shall not be controlled. It will serve as the indicator for the filter head loss. The maximum water level (admissible filter loss) must be such to allow free fall from the feeding channel / rectangular weir. Filters shall be cleaned when the water has reached that upper level. There shall be proper arrangements to avoid destruction of sand surface by freely falling water in case of a low water level in the filters just after cleaning. The lip of the outlet weir shall be at least 100 mm above the top of the sand bed to prevent media running dry.

Filtration shall be by gravity, downwards through a bed of filter sand. The filter sand shall consist of hard, durable grains of silica and shall have a specific gravity of not less than 2.5. All grains of sand shall be preferably water- worn. No supporting gravel media is to be used. It will result in less head loss due to reduction in bed height, prevent intermixing of soil media during back wash and filtration rate can also be increased.

The filter media (sand and gravel) shall conform to IS: 8419 (part I) amended up to date. Filter sand when immersed in 40% hydrochloric acid for 24 hours, the soluble matter shall not be more than 5% by weight. It shall not contain more than 1.5% of calcium and magnesium calculated as $CaCO_3$. Ignition loss should not exceed 0.7% of the weight. The solubility of supporting gravel in 40% hydrochloric acid after 24 hours shall not exceed 10% for 10 mm or larger size gravel and 5% for smaller than 10-mm size.

All filter media shall be supplied in polythene bags. Suitable care should be taken to protect the media from spillage or contamination. Storage on site shall only be in an approved area, well drained and free of mud and silt. The filter media shall be carefully placed in the filter beds and shall not be dropped or dumped or machine handled so as to be detrimental to the floor media, nozzles or sealant etc.

It shall be deemed that the Contractor has investigated all potential sources and verified that sufficient quantities of satisfactory filter sand can be obtained, packed and stored on site.

The under drain system should be of Vee Wire type be designed to provide uniform draw-off of filtered water and uniform distribution of wash water and air over the whole area of the filter. Particular provisions have to be made for the handling of the high air velocities at the inlet zone of the manifold.

Before filling the supporting layers and the sand of the filter beds the whole under-drains system shall be thoroughly cleaned and tested for equal distribution of water.

It shall be the responsibility of the Contractor to remove any debris before he commissions laying filter floors or laterals for excluding unwanted materials, which could block the filters.

Each filter shall have central and lateral wash water troughs that shall be connected with adequate slope to the wash water outlet to prevent deposits of silt. They shall allow an equal withdrawal of the wash water during back-washing the filter. The filter backwash water shall ultimately be discharged to sludge chamber.

A float switch shall be provided at the maximum admissible level of each filter to indicate the need for back washing. All equipments, sensors and automation equipment/devices for desired operation of I&C PANEL system shall be provided with required cabling and trenching works.

Filters :		
	Filtration rate	7.0-9.0$m^3/m^2/hr$
	Water column	1.0-2.0 m
	Free board	0.3m

Filter media :		
	Depth of sand bed	60 - 75 cm
	Effective size of sand particles	0.5 - 0.7 mm
	Uniformity coefficient of sand	1.3 - 1.7
	Depth of gravel layer	30-50 cm
	Maximum number of filter units with two halves	4 beds

Underdrainage system

It is proposed to provide the direct retention under drain system. The direct retention under drain system has fine slits (holes) enough to directly stop the loss of this fine sand without need for any additional support gravel layers.

The V Wire under-drain system is designed using unique V Wire screens. The system is header – lateral type. V Wire technology of making screen combines following features together;

- Large % open area at fine slit opening
- Non clogging slot profiles
- Sufficient strength and long life non corrosive.
- Ventury (jet) effect at the time of backwashing.
- Uniformly distributed slits across the periphery and length of the screen providing large no. of collection arcs (not points) across the length (app. 500 nos. per meter length).

The system is header – lateral type and can use existing header. The main constructional details are explained as follows –

i. Pipe base V Wire screen laterals – These are the heart of the system. Following are the salient constructional features –

a) The laterals are of sufficient length to cover entire bed and are placed at appropriate center distance across the length of the bed to provide effective collection and backwash area.

b) The laterals are made by fitting a perforated base pipe inside the V Wire screen of appropriate size of slit opening to retain the fine sand media. The base pipe is UPVC

and screens are necessarily made of SS 304 stainless steel. The base pipe is closed from one end and other end has connection to suit the header manifold.

c) The base pipe has uniformly distributed holes over the periphery for uniform collection of water during filtration & back wash.

d) It forms a water channel jacket around the base pipe between the screen profile wire inside surface and base pipe OD to provide a free pool of collected water to flow freely thru the perforations of the base pipe.

ii. Header – Existing header is used.

iii. Back wash system – Separate air header is provided with drop tubes to all the pairs of laterals. The drop tube connects to the flow divider inside the manifold and finally to extended nozzles extending into both the lateral base pipes individually. This ensures delivery of air right into the last zone to ensure most effective utilization of air and prevent diffusion of air pressure. Moreover this result into the air and back wash water flowing in the same direction. The back wash water is fed thru the main header and then to the laterals. The air does the job of scouring and media fluidizing and water does the job of rinsing and taking away the impurities. Hence the head of the water is required just to overcome the frictional losses of the system and to raise the water level up to the level of backwash outlet gutters.

Filter operation gallery and pipe gallery

Minimum guaranteed filter run shall be at least 24 hrs under all conditions. Each filter shall be provided with necessary electrically driven butterfly valves having control through I&C Panel and filter console as per approval of Engineer in Charge and push buttons provided on the filter operating console. The valves shall have the possibility for manual operation from the pipe gallery in case of problems with the drive. The following valves/gates shall be provided.

- Filtered water outlet (electrical.)
- Backwash water inlet (electrical.)
- Air inlet (electrical.)
- Backwash sludge water outlet (electrical.)
- Inlet (electrical.)
- Drain valve for maintenance

The valves shall be connected to pipe branches coming out of the filter box. These outlet and inlet pipes and inlets shall be provided with proper wall ducts without any leakage.

In line type DP transmitter type flow meter with 2% accuracy with 4-20 mA signal output, flow transmitter with local display and a regulation valve shall be installed in the backwash water pipe coming from the reservoir. There shall be a locking arrangement in regulation valve that can be locked after adjustment of flow. The flow rate (m^3/hr)

shall be transmitted to a wall mounted electronic digital meter of suitable size so that it is visible and readable from each filter operating console.

The electrically driven valves and the gates shall be operated from individual control consoles positioned adjacent to each filter in the operation gallery with visibility to the respective filter bed. These consoles shall allow for the following control functions (-c) and indicators (-i):

-c operation of the inlet gate and the valves (open/closed/intermediate position)

-i indication of the status of the gate and the valves (open, closed, intermediate, motor failure)

-c operation of the air blowers (on, off, failure)

-i signal lamp with acoustic signal if the water level in filter bed has reached the top level and the backwash cycle has to be started

-i indication of adequate water level in the backwash reservoir (yes, no)

The washing cycle of the filter shall be controlled automatically through I&C Panel or filter console as per approval of Engineer in Charge and shall have all provisions for its manual operation, step by step. Before back-washing, the filter water level has to be lowered to its minimum in order to avoid wastage,

The pipe gallery shall have the following piping arrangement:

- Backwash water pipe with connection to each filter
- Air pipe with connection to each filter

The filtered water pipe of each filter shall be connected to a small chamber with an adjustable rectangular weir to the central filtered water channel. This weir shall control the minimum water level in the filter. The weir crest shall be 10 cm above the top sand level of the filter. The length shall be designed to have less than 10 cm head. The completely covered channel (covered with Glass Sheets in lobby section and with RCC slabs in other sections) and shall lead directly to the chlorine contact tank. A small sump of adequate capacity shall be provided in the filtered water channel near the backwash pumps in the ground floor of the control building for the withdrawal of the water for the filling of backwash reservoir.

In the pipe gallery easy access to all valves and drives, cables etc. has to be ensured. If required, walkways and ladders shall be provided.

Back-washing of the filters

The filters shall be back-washed with water and air according to a cycle prescribed by the Contractor. One full filter bed / box (i.e. both the sections) shall be back-washed at the same time (simultaneously) to reduce down time of filters.

The water shall be delivered from a backwash reservoir providing the required volume and head, if necessary after throttling. The backwash reservoir shall be filled by centrifugal pumps, which will take the water from the sump in the filtered water channel. They shall have adequate capacities with which they also can cater for the process water for the chemical plant (solutions, injectors).

5.4.8. **Backwash reservoir pumps**

The contractor shall provide horizontal split casing/ monoblock centrifugal pumps (minimum two numbers with 100 % stand by units) along with suitable induction motor suitable for operating on 415V, 50 Hz frequency supply. The system shall be complete with suction pipe from the sump in the clear water channel, sluice valve in the suction, delivery pipe with spring-loaded non-return valve and sluice-valve. The delivery pipe shall be connected to the overhead back wash tank. The pumps will be designed to fill the full capacity of the tank in not more than 2 1/2 hrs. The system shall include the following:

- pipes and electrically operated butterfly valves for the suction and delivery pipes;
- pressure gauges with stop cock at the pressure side of the pumps;
- spring loaded non return valves in the delivery pipes;
- capacitance type water level indicator of the sump;
- low level float switch in the sump for automatic stop of the pumps;
- low level /high level switches for backwash reservoir to automatically start/stop back wash pumps

5.4.9. **Blowers**

The contractor shall provide blowers (minimum two numbers with 50 % stand by units) along with suitable induction motor coupled suitable for operating on 415V, 50 Hz frequency supply for the air delivery for scour of the filter beds. Each unit will be provided with a suction air filter and silencer, pressure relief valve and delivery non-return valve. A non-return valve shall be provided on common air main to each battery of filters.

The air pipe to the filter shall be laid with an apex above the max. water level of the filters to avoid back-flow and siphoning of water in the blower.

Pressure gauges with stopcock at the pressure side of the blower shall also be provided.

The air piping connecting the blowers to the filters shall be laid out on the ring main principle. There shall be a provision for the release of air from the system at the end of the scour before backwash commences.

Parameters:

Type of Filter Back-washing	Sequential Back wash System	Conjunctive Air and Water Wash System

Configuration	Minimum 1+1	Minimum 1+1
Vol. of free air	36-45 m/hr	45-50 m/hr
Vol. of water applied	24-36 m/hr	12-15 m/hr
Air pressure at under drain	0.35 Kg./sq.cm.	0.35 Kg./sq.cm.
Speed	1500 rpm	1500 rpm
Air velocity in pipe and valves	< 25 m/sec.	< 25 m/sec.

Machine Rooms:

The blower room of adequate size shall be provided to house the required nos. of air blowers and a pump room to house two backwash pumps. The number of pumps/ blowers shall not be less than two including 100% standby units shall be provided. The area where the pumps are installed shall be lowered to provide minimum 1.5 m positive suction head for the pumps. A drainage sump shall be provided at the deepest point of the lower area. The pit shall be connected to the drainage system.

A repair bay of minimum 3 sqm shall be provided in the pump room. A railing shall be provided around the lower part of the hall. The room height must be sufficient to allow loading and unloading of the pumps and the other equipment.

The control Panel for the units is also to be installed in that room. The following control functions (-c) and indicators (-i) shall be provided:

Pumps

-c Remote start, stop with manual override

-c auto start when backwash reservoir level middle

-c auto stop when backwash reservoir level high

-c auto stop when sump (at filtered water channel) level low

-c stop in case of failure of the motor

-i on, off, failure (repeat indications at Main Control Panel)

-i voltmeter, ampere meter, operation hours

-i low level in the sump

-i high, middle, low level in the backwash reservoir

-i flow of the backwash water coming from the reservoir

Blowers

-c Remote start, stop with manual override

-c local start, stop

-c manual start, stop from each filter control console

-i on, off, failure(repeat indications at Main Control Panel)

-i voltmeter, ammeter, operation hours

The status of both the backwash pumps and the blowers are also to be indicated at the main control Panel and I&C Panel control room of the treatment plant. The control operation shall also be possible from the I&C Panel control system. The status of the blowers shall be indicated on the filter control consoles also.

5.4.10. **Backwash Reservoir**

The backwash reservoir shall be of reinforced concrete. The capacity of the reservoir more than the minimum capacity indicated above and shall be sufficient to provide for quantity of water required for simultaneously back-washing of at least one full filter box + full water requirement for chemical & chlorine dosing + 10% extra for other utilities over the dead storage. It will have a minimum free board of 30 cm. The elevation of the reservoir shall be fixed according to the requirement of the backwash pressure. It shall also provide for the following:

- filling pipe
- Backwash pipe (outlet)
- Branches for the supply to the Administration & Control Room, chemical house and chlorine building and other utilities within the Treatment Plant Campus at Machla Magra.
- Butterfly valve in the outlet pipe
- Overflow pipe back to the filtered water channel
- Washout with gate valve
- Top level float switch (stop pumps, signal to control Panel of pumps)
- Middle level float switch (start pumps, signal to control Panel of pumps) (adequate water-yes, signal to each filter console)
- Low level float switch (signal to filter consoles; backwash impossible)
- Internal wall mounted water level scale

All pipes passing the walls of the reservoir shall be provided with suitable pipe ducts so that there shall be no leakage.

The reservoir shall have an access to the roof, a cast iron cover, an Aluminum ladder for the access to the reservoir and two CI ventilation pipes at least DN 200 with cowls and wire mesh.

5.4.11. **Chlorination Chamber**

The minimum capacity of Chlorination Chamber shall be as indicated above. The chlorination chamber shall be a reinforced concrete structure. It shall be fed from the filtered water channel. The chlorine solution shall be injected by bottom mounted diffuser disks. The chlorine solution-feeding unit must be detachable for easy maintenance. There shall be no smell of chlorine at a distance of 10 m from the chamber. The minimum freeboard shall be 30 cm, but the walls shall be extended up to a height so that its top is 60 cm above the general ground level there.

All inner surfaces of the chamber shall be coated with white or light blue glazed tiles (lead free) laid in suitable cement mortar, resistive to the aggressive water. The project logo shall be provided on the bottom of the chamber using colored tiles. A tight window with a tight shutter shall allow for the inspection. The chamber shall be equipped with an underwater floodlight to be operated with a switch near the window.

The outlet to the CWR is a weir for the connection through channel to the CWR.

The chamber shall have a stainless steel cover; an aluminium ladder inside for the access and at least two aluminum ventilators of 150 mm with wire mesh.

5.4.12. **Chemical House**

The chemical house shall be planned, designed and constructed for the 23.71 MLD input capacity in one building and shall include space for **thirty days storage** of PACL. The chemical house shall have sufficient space for unloading of the chemicals, toilets etc. The ground floor shall be used for the 30 days storage of PACL. The first floor shall house the PACL/ Primary coagulant with space for second phase units, the dosing equipment for all chemicals required. Suitable staircases, platforms etc. shall be provided to have clear access to different units. The building shall be supplied with process water from the backwash water tank.

The architectural layout of the chemical house shall be functional, adapted to the regional climate conditions and has to give an aesthetic appearance bearing in mind the local environment and culture. It shall be in harmony with the other buildings in proximity and the treatment units.

The chemical house shall be supplied from the backwash reservoir by minimum pipe size DN 100. Branches minimum of DN 100 - DN 25 shall be installed for to the solution tanks for PACL, the booster pumps for the injector system for the chlorinators and the internal supply system. Separate pipeing system with minimum 100 mm dia shall be provided for chlorine scrubber and NaOH tank.

The regulation shall be made with the adjustable dosing metering devices/pumps. The dosing equipment shall have I/O ports and connections / suitable cabling for sending and receiving 4-20 mA signals to and from the I&C Panel. The control over dosing rates shall be capable of being exercised from the control room consoles. The solutions shall be conveyed through pipes to the injection points.

5.4.13. PACl /Primary coagulant solution dosing

The PACl/ primary coagulant dosing shall be made by dosing metering pumps. The solution tanks and dosing devices have to be installed at a level to be in a position to feed into the flash mixer. The diameter of the pipes in the chemical plant and to the injection points shall be a reasonable compromise between a sufficiently large diameter to prevent clogging and a satisfactory high flow velocity to prevent deposits.

The PACl tanks shall be minimum 2 nos., for 30 days storage of PACl solution. All tanks shall be of equal size. The capacity of tank shall be designed for supply of maximum 10 % strength of PACl solution with minimum 10ppm dose.

Tanks

The PACl/ Primary coagulant solution tanks shall be of reinforced concrete lined internally with with materials recommended for corrosive products i.e. FRP, PVC, HDPE and/or rubber. Alternatively storge tanks can be 4 layered HDPE tanks.

Each PACl/ Primary coagulant solution tank shall be provided with a ultrasonic level sensor and transmitter connected to instrument control panel and WTP SCADA.

Pipes and valves in the dosing plant

The pipes, fittings and valves shall be such that any of the PACl / Primary coagulant tanks can be used individually with any of the metering devices. The tanks shall be filled from the process water pipe system. Each tank shall have an outlet with strainer to the dosing unit, an outlet for complete drainage and an overflow. The service outlet shall be at least 20 cm above the bottom level of the tank. The entire piping and the fittings shall be in HDPE pipe 10 kg/cm^2 rating of suitable diameter. All valves for solution delivery up to the injection point and for wastewater from the tank shall be rubber lined diaphragm valves.

The pipe between the storage tank and the dosing device as well as the pipe from the dosing device to the injection point shall be ofHDPE pipe 10 kg/cm^2 rating. They shall be connected to the process water circuit so that a rinsing of the pipes between the storage tank and the dosing unit and downstream the dosing unit is possible after each stop of the plant. The valves in the pipes shall be installed accordingly.

pipes to the injection point

The pipes to the injection point in the inlet chamber shall be of HDPE pipe 10 kg/cm^2 rating. They shall be laid on pipe racks or trays to be fixed to walls of tanks and buildings or in covered pipe channels so that they are always accessible. They shall not be exposed to direct sunlight. The chemical pipes shall be fixed and jointed in such way that individual runs can be changed without dismantling adjacent pipes. No individual pipe run shall be longer than 5 m. The pipe diameters must correspond to the hydraulic conditions between the chemical house and the injection point.

In case of a distance of more than 30m between the dosing device and the injection point duplicate dosing lines have to be provided.

There shall be washouts at suitable points of the chemical pipelines at distances not exceeding 30 m. The pipes shall be clearly identified throughout the whole run as chemical pipe for PACl by means of plates every 20 m and by the colour code, which is used, on the display screen.

PACl / Primary coagulant solution feeder

There shall be at least 2 (1 working + 1 standby) dosing metering pumps for the PACl solution. They shall be connected to both the tanks such that they can be operated individually from each tank. They shall feed into the dosing line leading to the injection point. The control of the flow (outlet) shall be regulated automatically through modulation of stroke length communicated by the I&C PANEL on the basis of inflow rate and quality of raw water. It shall be possible to modulate the dose manually as well. The outlet to the dosing line shall be controlled by a solenoid valve. The inlet and the constant level shall be controlled by a float valve.

The dosing devices and their components shall be fabricated of non-corrosive materials (stainless steel, mild steel with rubber or ebonite coating, fiber glass, HDPE).

Handling of PACl

The PACl solution should be filled directly into storage tanks.

Supply & Use of Chemicals

Under the contract all chemicals including liquid chlorine for pre-chlorination, PACl, Lime etc. required to treat raw water shall be supplied by the contractor and used to achieve the required quality. The quantity of chemicals to be used will be assessed by the contractor on the basis of quality of raw water which varies from month to month. Contractor may be directed to use additional quantity of chlorination in case of some incidental demand arising due to unforeseen health hazards. It may be considered that at times PACl dosing may not be required in consideration to the quality of raw water. The decision of EiC shall be final with regards to use of chemicals. Record shall be maintained by the contractor to assess the use of chemicals to avoid any confusion.

Specifications for Chemicals to be used for treatment of water shall be as per Indian Standards and relevant standards where Indian Standards are not specified. Relevant Indian Standards for some of the items are as under:

PACl (Poly Aluminium Chloride) : PACl shall be of approved grade & tight suitable for treatment of water for drinking purpose. Specifications of PACl shall be as per IS:299

Liquid Chlorine:

Operation & control of PACl/ Primary coagulant dosing unit

The operation of the PACl/ Primary coagulant dosing unit shall be made from the I&C PANEL and also from a wall mounted control Panel installed in the Chemical room.

Operation and Control of the PACl Dosing Unit

Operation	Activity
Outlet of the dosing device	Manual Automatic when raw water pumps stop and start
Flushing of the dosing pipes after the stop of the dosing unit	Automatic

5.4.14. Chlorine Building, Chlorination, Chlorine storage

Notwithstanding anything herein specified, the bidder shall comply at least the provisions contained in IS 10553 (Part 1 to 4) regarding handling, storage and safety of chlorine. Chlorine building shall be in the Chemical house. One chlorination room and one chlorination control room shall be provided. The Chlorine building shall be laid out considering the pre & post chlorination requirement of the raw and treated water and this fact should be utilised to optimize the chlorine solution piping etc.

Pipe Branches from the Backwash reservoir shall supply the sprinkler system of the chlorine scrubber, the booster pumps for the injector system for the Chlorinators and the internal supply system.

Separate arrangements shall have to be made to accommodate 30 days requirement of chlorine for pre-chlorination of 3 ppm and the post chlorination as per guaranteed outputparameters. Chlorine storage area shall be sufficient to store 8 chlorine tonners for 30 days requirement for pre and post chlorination. The storage area shall be shaded with AC/GI sheets and surrounded on all the sides with 1.50 meter high brick masonry wall having an entranceto provide access for the chlorine tonners. Clear spacing between stored tonners shall be equal to diameter of tonners. Exhaust ventilation shall be provided at floor level in the hood.

The chlorine drums shall be placed on concrete supports with two steel rollers each for easy rotating of the drums as per relevant BIS code. Each tonner shall be provided with pressure gauge and isolating valve. The handling of the chlorine drums will be made with an electric hoist of a capacity of 2000 kg, capable to lift and move the chlorine drums.

A chlorine scrubber tower of minimum 8 m height and 900 mm dia of RCC will be installed at least 6 meters away from filter block. From the exhaust fan in hood the exhaust shall deliver the leaking gas in the scrubber bottom where facilities for exhaust from top shall be available. From top NaOH solution and water shall be sprayed for neutralization. The exhaust shall be designed to deliver the equivalent gas volume of 900 kG chlorine in 4.5 hours. The discharge of water and NaOH solution shall be provided from the bottom of the Scrubber with a S or P trap to the drainage system so as to ensure no leak of gas from scrubber to drainage system. The exhaust shall be auto operated as the chlorine sensor detects chlorine levels in ambient area of hood more than the prescribed limits. The chlorination plant will comprise a container store area, chlorinator, container store, vehicular access, mechanical container handling facility and a chlorine neutralization pit with a lime slurry feeder. All safety features and equipment shall be provided to meet with any accidental eventuality.

5.4.15. **Chlorinators**

The Chlorinators shall be installed in a separate chlorinator room in the Chlorine building. The room shall be reasonably gas tight and shall be provided with a ventilation system delivering to the roof level. A set of continuously running exhaust fans at floor level shall exchange the air three times per hour with ventilators at 2.0m level. Emergency fans shall exchange it 20 times per hour. The doors of the room shall open outward.

The process water for chlorine solution shall be drawn from the pipes coming from the backwash water reservoir.

The Chlorinators shall be adjustable within a range of 1:10 according to the chlorine requirements of the raw and treated water. The tolerance of adjustment is not more than +/-4 %. Pressure gauges, indicating chlorine gas pressure and injector pressure shall be mounted on the front of the chlorinator and calibrated in metric units.

An injector module to suit the capacity of the chlorinator shall be provided with each chlorinator. A spring diaphragm check valve (to close injector suction part when the injector is not operating) a ball check valve or both shall be incorporated in the injector to prevent the back flow of water from the injector into the chlorinator. The injector has to be designed according to the available pressure conditions, which are governed by the available head in the backwash water reservoir at its lowest level. The flow of the injectors shall be controlled with the help of rotameter. If the pressure is not sufficient a booster pump system with small air vessel shall be provided to increase the pressure to the required level.

All parts of the Chlorinators, the injector and its accessories shall be of suitable material resistant to the chlorine (silver, silver plated Hastelloy C, PVC, Teflon, Borosilicate glass, ebonite lined cast iron).

The Chlorinators and their injectors shall be wall / floor mounted with suitable mounting brackets with anchor bolts. All connections, valves and other parts of the Chlorinators shall be easily accessible for cleaning, maintenance and repairs. Pipe connections shall be flexible.

The complete chlorinator and injector units shall be piped, and pre-tested as a system with all necessary valves, inlet connections, gauges and orifice control.

There shall be neither reactor towers nor evaporators. The sets along with booster pumps will be provided for designed capacity.

Operation of water and booster pumps for the chlorinators

The water supply shall be made from the internal system. The pressure shall be boosted by two centrifugal booster pumps for vacuum type to be installed in the Chlorine Building, adjoining to the chlorination room.

At least two pumps shall be supplied with isolating valves and the pressure gauges on delivery and suction line and valves by pass with pressure release valve from delivery to suction for each pump. The pump shall be connected to the common pipe fed from the back wash water tank. The pumps shall be identical and suitable for single and parallel operation.

The pumps shall be directly coupled to drive motor by flexible couplings. The pump and the drive motor shall be mounted on a common base plate of steel. Foundation or ground bolts shall be supplied for each base plate.

The drive motor shall be of horizontal spindle, totally enclosed fan cooled squirrel cage motor and shall be manufactured, tested and provided with insulation to class E or better. Starting device shall be as detailed below. The rating of the motor shall be at least 25% higher than the maximum power required by the pump over its operating range. The operating voltage of drive motor shall be 415 volts, 3 phase, 50 Hz.

Chlorine and solution pipes

The gas and water piping system shall be designed according to the chlorine and injection water flows and the hydraulic/pressure conditions. The pipes shall be laid as straight as possible on the shortest route from the drums to the Chlorinators. They shall be fixed on well supported trays / brackets and adequately sloped to allow for drainage. All steel supports shall be heavily painted in chlorinated rubber paint.

The connections of the chlorine gas pipes to the cylinders and the Chlorinators shall be coiled for flexibility during operation and maintenance. Each connection shall have a valve, a solenoid valve and a pressure gauge. All pipes and valves of the connection

shall be placed out of the reach of gas cylinders hanging on the hook during manipulation. Not more than 4 gas drums shall be connected to a common withdrawal header.

Pipe material for the chlorine dosing plant

Medium	**Construction material**	**Test pressure**
Chlorine gas	soft seamless copper tube with compressed fittings	25 kg/cm²
Injector water (with or without boosting)	Galvanised iron pipes and fittings, class C	10 kg/cm²
Chlorine solution	Rigid PVC pipes and fittings, class 3, not exposed to open sunlight	10 kg/cm²

After installation, the chlorine gas piping system shall be cleaned and dried. After drying, the system shall be pressurized with dry air up to the test pressure and tested for leaks by application of soapy water to the outside of all joints and connections. Leaking joints shall be repaired, and only when all joints are made leak proof chlorine gas shall be gradually introduced and the system shall again be tested for leaks.

The pipes for water and chlorine solution shall be tested with water with the respective test pressure.

Neutralisation Tank

One neutralisation tank of reinforced concrete shall be provided at a suitable location outside filter house. The capacity of which should be to neutralise full one and half chlorine tonner. It should be filled with suitable neutralising agent such as caustic soda (NaOH).The opening of the tank should permit the chlorine cylinder inside in any position. Its top should be covered with some thin plywood type cover which can be broken up easily in the emergency by the tonner itself. The tank should be lined from inside with suitable material so that the chemicals may not have any aggressive effect. The position of the tank should be such that the cylinder can be dumped into the tank easily. Location of the tank shall be designed so as not to interfere the normal entry-exit of the filter house. The tank shall be flushed with ground and the site shall be suitably fenced all round with a lockable gate. Height of fence shall be minimum 1.5m.

Chlorine Leakage control system and security equipment

For the detection of excess concentrations of chlorine in the air of the chlorinator room and the chlorine storage area leak detection devices are to be provided at suitable sites. Two levels of detection are envisaged:

Level of detection of chlorine leakage

Detection level	Action	Installation site and number
Chlorine concentration at or below the level of human perception: Concentration level 1mg/l, adjustable between 1 and 5 mg/l	Indicator lamp, acoustic alarm at the chlorine plant and at the main control room; automatic start of emergency exhaust fans	1 for drum storage area 1 for chlorinator room
Abnormally high concentrations which could occur on leakage or failure of the chlorinating equipment: Concentration level 5 mg/l	Indicator lamp, acoustic alarm at chlorine plant and at main control room; automatic opening of valve of sprinkler system; closing of chlorine valves, closing of injector water valve	2 for drum storage area

The Contractor shall provide following safety equipment in the works, as a minimum:

- Canister type respirators with full face coverage masks suitable for chlorine gaseous atmosphere - min. 2 no.
- Spare canisters for the respirators - min. 2 no.
- Self-contained compressed air breathing apparatus complete with working whistle and two spare air cylinders - min. 2 no.
- A facility to recharge the compressed air cylinder or from a self contained machine.
- Protective clothing such as PVC overall and gloves and rubber boots shall be provided - min 2 sets.

These equipments shall be stored in glass fronted non-locking steel cabinets so that any deficiency in the equipment shall be apparent. 15 m hoses DN 1" with jet and spray nozzle and valve are provided near the chlorine drum storage area in non-locking steel cabinets. They are connected to the process water system. The cabinets shall be located at strategic places in the chlorination room and near the storage area with view to easy and safe accessibility in case of chlorine leakage.

The Contractor shall provide visual and audible alarm system. Flashing warning lights shall be provided over each door of the chlorination room store and near the chlorine drum storage area. The lights shall be RED in colour and shall be clearly visible at a distance of 20 meter under normal daylight conditions. They shall be activated

automatically from the leak detection devices. Behind the lights a rear engraved perplexes label having red letters on a white background shall be mounted at each door and at visible place. The lettering shall be a minimum of 50 mm high and one legend shall read in English and the other in Hindi language.

DANGER

WEAR BREATHING APPARATUS BEFORE ENTERING WHEN LIGHT IS FLASHING

One emergency drum leakage repair kit shall be provided in the workshop or in the chlorinator room.

Number and location of security devices

Equipment Location	Respirators	Spare canister	Breathing device	Protect. clothing	Warn. light	Hose
Chlorination room	1		1		2	
Chlorine drum storage area	2		2		2	2

Operation and control of the chlorine dosing plant

A dedicated control Panel shall be provided in the chlorination control room. The operation of the chlorination plant is as follows:

Operation of the chlorine dosing plant

Operation	**Pre-chlorination**	**Post-chlorination**
regulation of the chlorine rate	Automatic with manual override , according to flow measuring channel and instructions passed from the control room through I&C PANEL on the basis of Raw Water quality	Automatic with manual override , according to flow measuring channel and instructions passed from the control room through I&C PANEL on the basis of Treated Water quality

Operation	Pre-chlorination	Post-chlorination
regulation of the process water	Automatic,	Automatic,
stop of chlorine gas flow	Manual	Manual
	Automatic when raw water flow is zero	Automatic when raw water flow is zero
	Automatic when injector stops	Automatic when injector stops
	Automatic when chlorine pressure low (gas drums empty)	Automatic when chlorine pressure low (gas drums empty)
stop of injector water	Manual; automatic when chlorine pressure low (gas drums empty) or in case of leaks	Manual; automatic when chlorine pressure low (gas drums empty) or in case of leaks
stop of chlorine flow at the chlorine drums	Manual; automatic in case of leaks; automatic in case of stop of injector	Manual; automatic in case of leaks; automatic in case of stop of injector
acoustic alarm	Automatic in case of leakage in the chlorinator room or in the chlorine storage area; low chlorine level/ high chlorine level	Automatic in case of leakage in the chlorinator room or in the chlorine storage area; low chlorine level/ high chlorine level
Continuous fans in chlorinator room	Manual; running continuously linked to the emergency power supply system	Manual; running continuously linked to the emergency power supply system
start of emergency exhaust fans in chlorinator room	Automatic in case of leakage in the chlorinator room; low chlorine level linked to the emergency power supply system	Automatic in case of leakage in the chlorinator room; low chlorine level linked

Operation	Pre-chlorination	Post-chlorination
		to the emergency power supply system
sprinkler system storage area	Automatic in case of leakage in the chlorine storage area; high chlorine level	Automatic in case of leakage in the chlorine storage area; high chlorine level
Start chlorination	Automatic when raw water flow start	Automatic when raw water flow start

5.4.16. **Waste water Recycling**

For recycling of the waste water from the drainage system, the drainage line from the filter area (wash water gallery & tube settler/clarifier) shall be taken to a sludge settling tank for 24hour detention period. The settled waste water from this tank shall be decanted to an adjoining tank from which it shall be pumped to the inlet chamber. 100% standby pumps shall be installed. Decanted water shall be re-cycled to filter plant after ascertaining that turbidity of water is not more than 500 NTU.

The sludge from the settling tank shall be pumped at a suitable point within 200 meters of the campus or as per site given by Engineer in Charge. All related electrical & mechanical components and piping arrangements are included in this scope of work. The minimum total live capacity of both recycling tanks shall be 460 KL. Its shape will be rectangular with 30cm freeboard & 25cm sludge deposition depth apart from live capacity. It will be open to sky.

5.4.17. **sludge buffer tank**

Sludge buffer tank shall be provided to store sludge from Tube Settlers/ clarifiers. The capacity of buffer tank is proposed for ultimate requirement i.e. flow of 23.71 mld. Pumps shall be provided to pump this sludge to sludge thickener.

5.4.18. **sludge thickener**

The sludge from backwash recycling tank and sludge buffer tank will be pumped to sludge thickener to reduce the volume of sludge to be handled. The consistency of thickened sludge is expected to be around 5%.

The sludge thickener is proposed to be provided for requirement of both the phases. With a solid loading rate of 50 kg/sqm/day.

The supernatant from thickener shall be collected in a separate supernatant sump from where it will be pumped to inlet chamber for recycling. The thickened sludge from sludge thickener shall be collected in thickened sludge sump from where it will be pumped to sludge drying beds.

5.4.19. Supernatant sump/centrifuge/ Volute Type Screw Press

The thickened sludge from sludge thickener shall be pumped to Volute Type Screw Press/ centrifuge where its consistency will further increased in the range of 20-30%, from where it can be may be trucked to a sanitary landfill. Under this project Volute type screw press dewatering mechanism with sludge conditioning tank is advised to be used instead of conventional sludge dewatering systems. This innovative sludge dewatering product offers many advantages over conventional sludge management methods. Originally developed in Japan, the Volute Dewatering Press is patented worldwide, with more than 650 installations. The key to the process is the unique dewatering drum design. This drum is able to achieve both thickening and pressing (dewatering) of the sludge in a single, compact operation. It can take sludge as dilute as 0.1% solids, directly from a biological process, such as an oxidation ditch, and produce a cake of over 25% solids. The final decision of the method to be used will be of Engineer Incharge.

5.4.20. Sludge handling and final disposal

The sludge shall be handled and disposed in environment friendly manner. The Contractor shall carry out all required disposal works and create/construct requisite facilities for final disposal of sludge at land provided by the department. The scope also includes getting environment clearance certificate from competent authority for the development of the sanitary landfill.

5.4.21. Laboratory and Sampling System

The quality of the water entering, passing and leaving the treatment plant shall be monitored via HDPE sampling pipes DN 25 from the following points leading to the laboratory:

- raw water pipe at the inlet chamber (raw water)
- outlet channel of the clariflocculators (clarified water)
- end of the filtered water channel
- outlet of the chlorination chamber (treated water)

The sampling pipes shall lead from the sampling point to small sampling pumps installed at a low area of the pipe gallery of the filters. From there, pressure pipes shall lead to the laboratory to the outlet points.

The laboratory shall have the equipment, storage space and chemicals for all the chemical and bacteriological routine analyses. The laboratory shall have 3 m long

working platforms with minimum 3 sinks. The sampling pipes shall end at one of the sinks. The taps shall be clearly labelled with the type and provenience of the water.

A portable direct reading turbidity meter shall be provided for the measuring of the turbidity at the individual measuring points.

The provision shall be kept for two nos. (one working + one standby) online continuous turbidity meters with displays in the central control room and the laboratory. Adequate digital/analogue signal shall be provided by these turbidity meters so as to control the dosing of alum / lime and polyelectrolytes.

5.4.22. **Control room**

- The main control room shall be sited in Administration and Control Building. The supervision of the entire plant shall be possible from the main control room. There shall be a Man-machine interface and a control console. The mimic diagram (to be available on 17" colour monitor) shall show the whole treatment plant configuration.

5.4.23. **Colour code for pipes**

All visible pipes in the different units of the plant shall be painted according to a distinct colour code. This colour code shall also be used for the presentation of the pipes on the mimic Panel.

Colour code for pipes

raw water	dark green	air	yellow
settled/filtered water	light green	sludge, sludge water	brown
treated potable water	light blue	Chlorine solution	red
backwash water	Blue	Alum, lime	pink

5.5. **Electric Supply, Earthing and Lightning protection**

5.5.1. **Electric Supply**

The treatment plant shall house the LT control panel and distribution boards. The treatment plant will be supplied with LT cables from the main transformers. The distribution Panel for the treatment plant will be installed in the main distribution Panel room in the ground floor of the control building. From there, the internal supply to the individual sub-distribution Panels will be as follows:

- control Panel for backwash pumps and reservoirs;
- control panel for Pumps installed at CWPS Machla Magra
- control room;
- all other rooms of the control building;
- filter pipe gallery;
- filter operation gallery;
- local Panels of the Flocculation zone and Tube Settlers/ clariflocculators;
- chemical house;
- Indoor and outdoor lighting of all the rooms and units and all other energy consumption points.

It is in the scope of the Contractor's job to design and submit drawing of entire proposed system so as to ensure coverage of the full requirement of the plant.

The LT cables are laid in cable ducts, on cable trays or in drained cable channels/RCC pipes. They shall be neatly laid in straight alignments and along the shortest route. The electrical installations have to be made according to the specifications presented herein.

5.5.2. **Earthing and lightning protection**

General Earthing shall be provided as per IS 3043.

Lightning protection shall be provided as per IS 3043 using GI conductor of suitable size for all buildings and tanks/reservoirs. The top most bar conductor shall be of gunmetal.

5.5.3. **Lighting and Electrical Fittings**

Outdoor flood lights on poles or suitably fixed on walls shall be provided for adequate lighting at all treatment units of the plant. At each unit there shall be a 15 A waterproof outdoor socket for maintenance purpose. The minimum requirements are:

- inlet chamber : 1 light
- flume : 1 light
- mixing chamber : 1 light
- clariflocculators : 1 light at the center; 1 light at the outer part of the bridge
- filters : 1 light per filter

Along walkways and channels outdoor lights shall be provided at a spacing of 15 m. on poles.

Indoor lighting shall be provided for all rooms of the plant according to the detailed electrical specifications. The minimum illumination level shall be as per the electrical equipment section. As far as possible, all bulbs and lights shall be of the long life and energy saving type.

Lamps shall also be provided at each entrance of the buildings.

Sockets of 5 A and 10 of 5/15 A shall be provided in all rooms of the control building and the chemical house according to the instructions of the Engineer-in-Charge. At least two spare three-phase sockets shall be provided in the pump room. Sub distribution and circuit breaker Panels shall be provided at suitable places.

Ceiling fan shall be provided as per instructions of Engineer in Charge. Their sweep area shall be at least 1.5 m in diameter.

Except as specifically approved by the Engineer-in-Charge, installation of conduits and lighting fixtures shall be commenced only after all major services in that particular area has been completed. 5A 3-pin receptacles with switches shall be provided on the light control switchboards, whereas 15A, 6 pin receptacles with switches shall be provided at skirting level.

Lighting Panels shall be provided with labels indicating LP number and O/G circuit feeder numbers.

5.6. General requirements for pipes, specials and valves

5.6.1. Pipes

Pipes carrying raw, settled or filtered water shall be of cast iron/ductile iron, flanged or with spigot and socket joints with rubber rings, according to individual circumstances. Generally, the following materials shall be used:

raw water, clear water, interconnection between the units	MS flanged with epoxy coating or cement guniting/ cast iron socket/spigot LA class and flanged medium range/ ductile iron class K7
sludge, waste water, overflow	Cement concrete hume pipes with rubber rings
process water in the plant, internal drinking water supply	Galvanised iron pipes, threaded joints; PVC class 3 for underground pipes
Air	Galvanised iron pipes threaded joints, or MS pipes, welded
Conduits	Mild steel (visible) or PVC (cast in concrete slabs etc.)

Pipes carrying chemical solutions or solutions or gases shall be selected according to the properties of the medium after approval of the Engineer-in-Charge Jointing shall be kept

to a minimum. All flexible pipes shall be supported on walls, or laid on trays or in pipe channels etc. to avoid sagging. Drain cocks shall be provided to empty the pipes whenever necessary.

All pipe work and fittings etc. shall conform to the appropriate Indian Standards and shall be to a class in excess of the maximum pressure they will attain in service including any surge pressure and shall be supplied by an approved manufacturer. All pipelines shall be tested at 1.5 times the design working pressure.

The internal surfaces of all pipe work shall be thoroughly cleaned before and during erection and before the pipe work is placed into commission. All pipelines shall be properly painted as per the specifications

5.6.2. **Valves and appurtenances**

All sluice gates, butterfly valves, air release valves, check valves shall be designed for the medium carried in the respective pipeline, according to the diameter and the design working pressure of the pipeline. Manual operation shall always be provided, electrical drives shall be provided as specified.

The valves shall be installed between flanges. The dismantling shall be possible by the use of rigid or flexible dismantling pieces or flange adapters at one side.

For this purpose, suitable flange adapters may be provided. All valves shall be installed in the pipe work in such a manner that they can easily be removed from the line for dismantling and maintenance.

The non-return valves on the pump delivery branches shall be spring loaded and have high speed non slam closing characteristics.

Valves used in lines conveying chemical solutions and gases shall be manufactured of material suitable for the purpose and to withstand the corrosive and aggressive action of the medium.

Valves used on sludge conveyance piping etc. shall be of straight through type and non-clogging.

Valves used shall conform to the respective IS specifications.

5.7. **Emergency equipment (general)**

5.7.1. **Fire extinguishers**

The Contractor shall provide 5 CO2 fire extinguishers (10 kg) for the treatment plant at the following locations after consultation with the Engineer in Charge:

- Main distribution Panel room

- Pump and blower room
- Control room
- chemical house

5.7.2. **First aid kits**

Complete first aid kits shall be provided for:

- Administrative Block
- Chemical house

The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns bad effects of inhalation of chlorine, bad effects on skin due to contact of chemicals acids etc. Following materials in general in sufficient quantities shall be provided.

- Medical cotton, sterile cotton pads
- Cotton Bandages, elastic bandages
- Pair of scissors, packet of new shaving blades
- Sticking plaster for medical use.
- Band aid stripes.

Following chemicals/medicines shall be provided in sufficient quantities:

- Tinctures iodine and mercury chrome
- Burnol ointment
- Bottles of spirit and of Dettol
- Toilet soaps

5.8. **Spillage and Leakage**

Chemical preparing, dosing and transfer equipment shall be designed and arranged so that any leakage and spilling can be controlled and cannot enter ducts, channels, etc. and have a corrosive impact on pipes, cables or other equipment of the plant.

At all lubrication or greasing points grease trays or pans shall be provided to collect excessive lubricant or spillage onto the equipment or into water.

5.9. **Packing, transportation, handling**

After inspection and clearance by EIC or his authorized inspecting agency at the manufacturer's place, wherever applicable, the Contractor shall arrange and co-ordinate with all concerned agencies for proper and expeditious packing, forwarding, transporting, unloading from carriers at site, inspection and storage at site and subsequent transfer to the site or to the Contractor's store.

Prior to dispatch all plant shall be adequately protected by painting or by other approved means for the whole period of transit, storage and erection against corrosion and incidental damage, including the effects of vermin, sunlight, rain, and hot and humid climate.

The flanges of pipes, valves and fittings shall be protected by wooden discs attached by means of service bolts (which shall not be used at site) or by other approved means. The sleeves/flanges of flexible couplings shall be bundled by wire. Machines, Panels and other equipment shall be suitably packed and protected so that damage shall be excluded.

Heavy equipment shall be packed in such a manner that handling during transport and unloading shall be possible with adequate equipment. Rubber rings, bolts, nuts and other small items shall be packed in cases which normally shall not weigh more than 100 kg gross per case.

The Contractor has to ensure that the required, suitable handling equipment is available at his workshop, during interim storage and handling, and at the site for loading, unloading and erection.

All items whether individually or packed in cases shall be clearly marked with undeletable paint for identification against the packing list. Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of the packing list shall be sent to the Engineer-in-Charge

The packing shall be in accordance with the requirements of the carrier and the lifting and handling equipment so that damage during transport, interim storage and handling can be excluded. The items have to be marked according to their vulnerability so that the handling and transportation staff can assess the contents and the required way of handling.

After unloading a quantitative and a visual check will be made by the Engineer-in-Charge against the packing lists. This check is not a final inspection or acceptance and does not incur any payment unless stated in the Contract. Damaged items or items in doubtful condition will be refused and have to be replaced by the Contractor at his cost; lost items shall also be replaced at his cost. In case of minor damages the Engineer-in-Charge may accept a repair on site provided the condition at the time of factory inspection can be fully re-established.

Equipment delivered to the site or installed shall be adequately protected against impacts, climate, damage to finished surfaces, fitted components, cable or pipe connections etc. The Contractor shall make good to the satisfaction of the Engineer-in-Charge any deterioration of the protective coatings, paint work, fittings etc. which may occur during transportation, erection, commissioning etc. until the plant is taken over.

5.10. **Erection**

General

The contractor's staff referred to in the Conditions of contract shall include at least one competent erection engineer having sufficient erection experience and who should be a permanent employee of the Contractor, to supervise the erection of the works using sufficient skilled, semi-skilled and unskilled labour to ensure completion of the Works in time. The contractor shall not remove any representatives, erectors or skilled labour from the Site without the prior approval of the Engineer-in-Charge.

The Contractor shall be responsible for setting up and erecting the Plant to the line and level required and shall ensure that such Plant is kept in position whilst being built in, and he shall not pass this responsibility to the civil contractor.

Where the Works are associated with or in physical contact with plant supplied under a separate contract, the Contractor shall satisfy himself that the work carried out by the other contractor is consistent with the correct operation of the Plant. In the event of the Contractor considering any work being carried out or any work already completed to be detrimental to the completion or ultimate operation of the Plant, he shall report the matter at once to the Engineer-in-Charge in writing.

Depending on the progress of other associated contracts, the Engineer-in-Charge with his best judgement may allow access to part/ parts of Site with due consideration to Contractor's programme and commitment to contract Time. The appropriate Contract Time for the particular item or group of items shall be deemed to have commenced from the date the part access is given.

Levelling and Grouting of Machinery

The pumps, motors and other equipment shall be properly and accurately levelled and aligned on the concrete plinth by means of tapered metal wedges and metal packing pieces before any grout is poured. After correct alignment and levelling the foundation bolts shall be nipped up to hold the machine firmly in position and it shall be the Contractor's responsibility to check that the position is maintained after the grout has been poured but before it sets. The grout, which will contain an approved expanding agent, will be mixed and poured by the Contractor. ACC shrinkomph, grout mixer or equivalent is to be used for grouting.

The horizontality of base plate top shall be within 0.05 mm/metre. The base plate top surface and pump motor box are to be blue matched to get a contact area of at least 80%.

After the grouting mixture has set hard the foundation bolts shall be pulled up hard and the alignment and level rechecked. The Engineer-in-Charge shall be informed at all times of the progress of this work and when any checks on alignment and level are to be carried out so that he may witness the checks if he so requires. The approval of the Engineer-in-Charge or his intimation that the alignment or level of the machines is to his

satisfaction shall in no way relieve the Contractor of his obligation under contract to properly install and align the machines and pipe-work and shall in no way prejudice the Engineer in Charge's rights to order rectification of any installation work later found to be improperly carried out.

5.11. Specifications Of Main Material And Equipment And Inspection

The specifications and standards of the main equipment of supply are laid down in the following paras. This does not cover the entire list of material and equipment that would have to be supplied and all the material not covered will be supplied as per the latest ISS. In case no ISS is available then it shall be as per relevant BS/AWWA/ ISO and shall be of the best quality.

The contractor is responsible for the equipment and material he supplies up to the end of the defect liability period and is expected to supply all materials only as per specifications. It is intended to approve drawings of some of the equipment before supply and also to inspect or to get inspected from a third party authorized by the Department before dispatch of some of the material and equipment. A list of items for which Pre-dispatch inspection is mandatory is available in the Chapter for Pre-dispatch inspection of this document.

It may however be noted that the contractor is responsible for the material and equipment to be conforming to the specification up to the commissioning and will bear the responsibility if found otherwise despite of a prior inspection/approval.

5.12. Mechanical Equipment

5.12.1. Back wash Pump:

Bank wash pumps shall be installed in the pump room and shall take water from the Chlorine Contact Tank. Generally from considerations of reliability, ease of operation and maintenance, a split casing/monoblock centrifugal pump is specified.

5.12.1.1. Codes and standards

The design, manufacture and performance of the backwash pumps specified herein shall comply with the requirements of the latest edition (as on date of submission of bids) of the applicable, Codes and Standards:

No.	Standard	Title
1	IS:6595	Horizontal centrifugal pumps for clear, cold and fresh water.
2	IS:9079	Technical requirements for monoblock pumps

3	IS:5120	Technical requirements for Roto-dynamic, special purpose pumps.
4	IS:9137	Code for Acceptance Tests for Centrifugal, Mixed flow and Axial pumps.
5	IS:13536 ISO:5199	Technical specification for centrifugal pumps - Class 2
6		Standards of the Hydraulic Institute of USA.
7	IS:13095	Butterfly valves for general purposes

Technical particulars pumps

Pump Designation	Back wash pumps
No. of Pumps	As per design, minimum 2 nos. (100% units standby)
Design capacity	As per design
Speed of pumps	Suitable for 2900/1440 rpm synchronous speed motors
Total Head required	As per design
Operation	Continuous
Combined Efficiency of Pump and motor	> 65%

Features of construction shall be as per relevant BIS.

General Features of Construction

Casing	Horizontal split casing/monoblock
Drive	Direct
Flange Drilling	IS 1538
Prime mover	Electric Motor as per vendor specifications of pumps

Liquid Data

Liquid Handled	Potable Water
Temperature	Ambient 45 Deg C (Range = 4 to 50 Deg C)

5.12.2. **BLOWER: -**

a) Codes and standards

For supplying air to Water Treatment plant Twin Lobe Blower is proposed. The design, manufacture and performance of blowers specified herein shall comply with the requirements of the latest edition of the applicable, Codes and Standards:

Standard	Title
BS: 1571	Performance Testing

b) Design requirements

The blower shall be capable of developing the required total pressure at rated capacity for continuous operation. The blower shall operate satisfactorily within the operating range.

The material of various components shall conform to those stipulated in the Technical Particulars section. Performance requirement for the blowers shall be guided by the data specification sheets.

Air delivery shall be clean, dry and oil free.

Blower shall run smooth without undue noise or vibration. Noise levels and velocity of vibrations shall be within acceptable limits. Noise level shall be limited to 92 dB(A) at a distance of 1.86 m. Vibrations shall be within 5 m/s2

The contractor shall ensure that combined sound level at any point 10 m away from the enclosure does not exceed 75 dB(A) when the working blowers are in operation. Other wise Suitable acoustic enclosure is required shall be provided.

Blower shall be air-cooled and driven by electric motor.

Unless otherwise specified in datasheets, power rating shall be at least 10 % above the maximum power required by the blower.

Blower shall be provided with suction air filter, silencer, dead weight pressure relief valve and pressure gauge.

Blower *shall be mounted at a level necessary to avoid back-flow or siphoning of water into the blower.*

5.12.2.1. **Features *of* construction**

Main Body

Main body/Casing shall have required rigidity, strength and heat transfer fins for smooth and cool blower operation. It should be mounted on anti-vibration base. Casing shall have proper in-volute shape on inner side machined accurately to achieve best efficiency.

Rotor

Both the rotors shall be properly machined for in-volute profile surface with treatment to increase wearing resistance. Rotors shall be properly keyed and locked to respective shafts. The designed clearance shall be so chosen that even at elevated temperature the clearance is adequate and efficiency is achieved.

Shaft

Both the shafts shall have high tensile strength and critical speed of the shafts shall be at least 20 % above the operating speed. Complete rotor assembly shall be dynamically balanced. The shaft shall be suitable to work at high temperature.

Shaft Sleeves

Replaceable shaft sleeves shall be provided to protect the shaft. Shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening. Shaft and shaft sleeve assembly shall ensure concentric rotation.

Bearings

Anti-friction roller / double row angular contact ball bearings shall be provided with proper lubrication. It shall be designed to take necessary radial load and axial thrust. Bearing shall be suitable for continuous duty operations and for high temperature operations arising due to compression of air.

Timing Gears

Timing gears shall be with high tensile strength, induction hardened and ground / lapped for high mechanical efficiency, low noise and longer life.

Oil Seal

Oil seals shall be suitable for high temperature application at continuous rating and shall have ensured life of at least 5000 hours.

Base-plate

The common base plate for blower and motor shall be in one piece and it shall be provided with suitable holes for grouting. Holes shall be so located that base can be grouted in place without disturbing the blower and motor. Blower and motor shall be properly aligned, bolted and dowelled to the base plates by contractor.

Connections

Suction and discharge connections shall be flanged and drilled to IS or equivalent standard unless otherwise noted in Data sheet.

Accessories

All specified accessories and any other standard accessories required for correct and safe operation of the blower shall be furnished with the blowers. All incidental piping (including valves) required shall be furnished by the contractor.

A mild steel fabricated coupling guard / bell guard shall be provided as a safeguard against the open rotating parts of the blower and the motor.

Eyebolts shall be provided for ease of lifting and installation (as many per blower as required for safety).

5.12.2.2. **Technical particulars**

A. Operating Conditions

1	Blower Designation	Twin Lobe Blower for Filter backwash
2	No. of Blowers	As per design, minimum 2 including 100% standby units
3	No. Normally working	1
4	Design capacity	as per requirement
5	Speed of blowers	1500rpm synchronous
6	Pressure requirement	as per requirement but not less than 0.40 m
7	Operation	Continuous

B. Features of Construction

1	Type of blower	Twin Lobe
2	Drive	Belt Drive
3	Prime mover	Electric Motor as per vendor specifications of pumps

Materials of Construction shall be as per relevant BIS

$(1+x)^n = 1 + \frac{nx}{1!} + \frac{n(n-1)x^2}{2!} + \cdots$. Accessories and Services Required

1	Companion Flanges	Yes
2	Base Plate	Yes
3	Foundation Bolts	Yes
4	Suction Air Filter	Yes
5	Silencer	Yes
6	Pressure Relief Valve	Yes
7	Pressure Gauge	Yes

5.12.3. **Pipes:**

The pipes used shall be as follows:

S. No.	Type of pipe	Class	IS for supply
1	Ductile Iron S&S	K9	8329
2	Cast Iron S&S	LA	1536
3	Cast Iron Flanged		6418
4	HDPE		4984
5	Rigid PVC	Class 3	4985
6	GI/MS up to 150 NB	Heavy duty	1239
7	Stainless Steel		6913
8	RCC Pipe S&S	NP2	458

All pipes, specials and flanges supplied and installed in the works shall have the same specifications as stipulated in Chapter for "Specifications for Pipes" of this document.

5.13. **VALVES GENERAL**

The specifications for butterfly, sluice, dual plate check, air valves, valve actuators and gear boxes shall be as stipulated in the Chapter of "Specifications for Valves and Pipe Appurtenances, of this document. Pressurerating of the valves shall be PN 0.6.

The valve actuator control Panel shall be provided with suitable NO/NC contacts for connectivity to the switchgear and the instrumentation control Panel. All valves shall be

provided with limit switches for modulation of flow and with an indicator to display the percentage open position.

5.13.1. **Globe valves**

Constructional Features

Valves of sizes 40 mm dia. and below will be inside screw rising stem screwed bonnet type having integral/renewable type seats. The valves of sizes above 40 mm NB will be outside screw and Yoke - rising stem bolted bonnet type having renewable body and disc seats. The discs of gate valves shall be solid wedge type. Discs for globe valves shall be renewable plug type, suitable for control. Gate and globe valves shall be furnished with back-seating arrangement for repacking while working under full operating pressure. Gate and globe valves shall be manual hand wheel operated, unless otherwise specified. The direction of rotation for OPEN / CLOSE position shall be marked on the hand wheel.

Valves of sizes 40 mm dia. and below will have screwed ends as per BSPT. For valves of sizes above 40 mm dia. the ends shall be flanged as per ANSI B 16.5.

5.13.2. **Non-return valves**

Constructional Features

Non-return valves shall double flanged and be installed on the delivery side of the pumps, and shall be suitable for installation in a horizontal pipeline. Rapid natural closing to be non-slam by suitable design of spring return mechanism, to ensure that the valve will rapidly fully close the moment forward flow of the water ceases i.e. on pump shutdown, external counter weights will not be acceptable. To prevent excessive head loss, larger diameter non-return valves will be provided with several smaller and lighter flaps in a single bulkhead. In this case stopper to be provided for the upper door to avoid contact with shell.

Materials of Construction

Body	CI to IS Gr FG 200
Door	CI to IS Gr FG 200
Spring	Spring steel BS:970
Body ring	S S. AISI 304
Door ring	SS. AISI 304
Hinge pin	AISI 410 /431 Hardened and ground

5.13.3. **DISMANTLING JOINTS**

The specifications of the item shall be as defined in chapter of "Specifications for Pipes" of this volume.

5.13.4. **Sluice GatesGeneral Specifications**

Sluice gates according to IS 3042 shall be provided in open channels for outlets to pipes, other channels or to filter beds etc. All sluice gates shall have proper arrangement for electrical operation for opening/closing and position indicator. They shall be suitably linked to the switchgears and instrumentation control Panel. They shall be square or circular, in standard sizes, according to the outlet conditions. The gates shall generally be mounted on the side from where the higher pressure shall generally be expected (seating). The gates shall be mounted on frames and provided with a non-rising spindle with headstock or electrical drive according to the site of installation.

In case of alternative load from either side, the sluice gate shall be designed to tightly close against a maximum unbalanced head (forcing the door away from the seat/frame) corresponding to 150 % of the maximum difference in the water levels or the difference plus 1 m, whichever is higher.

The frame shall be with gunmetal seating faces, machined to match with the faces of the door. The frame shall have a sufficiently broad flange of adequate section with drilled holes to fix it with anchor bolts. It shall have an integrally cast in spigot of the nominal size of the opening to be cast into the concrete. It shall have a side guide strip with a machined face up to the maximum open position of the door. The upper part of the frame shall have machined face to support a thrust plate. All anchor bolts and nuts of galvanised mild steel, joints and fixing elements shall be provided.

The door shall have reinforcement ribs depending on the size of the door and the unbalanced head. The adjustable sealing faces on the sides, bottom and top are of gunmetal and machined to match the seat on the frame. Sufficient margin should be there for wear and tear in course of use. On the back, tapered snugs shall be provided to match the tapered side guide strips of the frame. There shall be an integrally cast pocket in the upper part for the gunmetal nut threaded to suit the non-rising spindle.

The spindle shall be rolled on trapezoidal thread. It shall be provided with torsional couplings, cast iron guide brackets, and mild steel extension rod up to the headstock/drive. Ball thrust bearing arrangements shall be provided for long spindle.

The headstock shall be a cast iron pillar with an operating rod operated by a hand wheel on top, fitted with gunmetal index and pointer. The hand wheel shall be designed for operation by one man against the full unbalanced head (not more than 10 kgf). The maximum time for opening and closing of gate shall be 15 minutes with electrical actuation.

5.13.4.1. **Materials of Construction**

Frame	CI
Door	CI
Sealing faces	Gun Metal
Spindle	SS. IS 410
Head stock	CI

Hand wheel	CI

5.13.5. **Chlorinators:**

Vacuum type Chlorinators of modular construction floor mounted type shall be provided. They shall be provided separately for the requirement of the Pre chlorination. An extra standby unit shall be provided.

Gravity feed / Vacuum type chlorinators shall be provided for post chlorination with a standby unit.

All operating components shall be protected within a non-corrodible, non-metallic cabinet.

Chlorinators shall be designed to ensure safety to operating personnel.

Chlorine gas control system shall operate under vacuum / gravity to prevent gas leakage to atmosphere.

A Pressure regulating valve or suitable means shall be provided for automatic shut off of the chlorine gas on interruption of injector water supply.

Suitable safety provisions shall be made in the gas control system to prevent build up ofpressure or excessive vacuum as and when the chlorine supply runs out.

Flow meter consisting of a Borosilicate glass tube with etched graduations in metric units and a float of suitable approved material shall be supplied as part of chlorinator.

Flow meter shall be of direct reading type and properly calibrated at works.

Chlorine pressure gauges shall have or Teflon diaphragm and oil filled.

All metal parts of chlorinator shall be silver, or other noble metals.

Components exposed to chlorine shall be silver plated Hastelloy (C', PVC, Teflon, and extra heavy duty Borosilicate glass.

Chlorinator shall be designed so that all components shall be readily accessible for cleaning, maintenance and repairs.

Complete chlorinator shall be piped, and pre-tested as a system with all necessary valves, inlet connection gauges and variable area orifice control.

An injector module to suit the capacity of the Chlorinator shall be supplied with each chlorinator.

A spring diaphragm check valves (to close injector) suction port when the injector is not operating) a ball check valves or both shall be incorporated in the injector to prevent the back flow of water from the injector into the Chlorinators.

Injector shall be of PVC or ebonite lined cast iron or any other approved material. Suitable mounting brackets with anchor bolts shall be supplied for mounting injector modules.

5.13.5.1. **Booster Pumps with Drive Motors (If Necessary)**

The operating water supply to injector will be made available from overhead wash water tank and since pressure available may be that required for injector water needs, booster pumps may be necessary.

If the tenderer feels that pumping will be necessary then they shall quote for suitable motor driven, centrifugal pumps to deliver injector water supply in sufficient quantity and the pressure.

Injector water supply as specified above, shall be designed to suit the maximum rate output of the chlorinator offered.

Two pumps shall be supplied (one pump for each chlorinator) with isolating valves and the pressure gauges on delivery and suction line and valves by pass with pressure release valve from delivery to suction for each pump.

The pump shall be connected to a common 100 mm dia. suction manifold fed from the down take line of the wash water tank.

All pumps shall be identical and suitable for parallel operation.

All pipe flanges shall be faced and drilled in accordance with relevant IS specifications.

The pumps shall be directly coupled to drive motors by flexible couplings.

Both the pumps and the drive motor shall be mounted on a common base plate of cast iron or steel

Foundation or ground bolts shall be supplied for each base plate

The drive motor shall be of horizontal spindle, totally enclosed fan cooled, squirrel cage motors and shall be manufactured, tested and provided with insulation to class E or better.

Motor shall be suitable for star / delta starting, HP rating of motors shall be at least 25% higher than the maximum H.P required by the pump over its operating range. Operating voltage of drive motors shall be 415 volts, 3 phases, 50 cycles a.c. Drive motors shall be designed for continuous rating.

5.14. **Electric hoists**

5.14.1.1. **General**

Electric driven, short headroom, wire rope hoists with motor driven travelling trolley and I-beams for suspension shall be required in

Location	Vertical Lift	Movement area	Capacity	Electrical/Manual
Chemical House	From floor of chemical storage room ground floor to buckets in	From lifting point in floor to all chemical solution tanks	One ton excluding bucket weight.	Electrical

	chemicals tanks floor			
Chlorine yard	From floor of Chlorination yard to bottom of Neutralization Tank	From lifting point in yard to full area of Neutralizatio n Tank	One ton excluding bucket weight.	Electrical

The construction of the hoists, its components, the design, testing and commissioning shall conform to IS 3938, Class II duty. All parts needing inspection and/or replacement shall be easily accessible with the minimum need to dismantle other equipment,accessories or structures. All lubrication points shall also be easily accessible without the need for any dismantling of other equipment or accessories. The hoist must be equipped with adequate safety devices. The beam on which the hoist shall travel, shall be designed, supplied, installed and tested in conforming to the relevant Indian Standards.

5.14.1.2. **Mechanical details**

The specifications of the hoists are as follows:

Specifications of the hoists

Rope Drums	Rope drums shall be of cast steel or fabricated from rolled steel plates, conforming to the relevant Indian Standards. Fabricated rope drums shall be stress relieved before any machining takes place. The drum grooves shall be smooth finished and the rope drum shall be flanged at both ends. The drum shall be designed for a single layer of ropes. A precision machined rope guide to suit the drum grooves shall move over the drum like a nut, guiding the rope into the grooves and preventing an overlapping of the rope.
Brakes	Brakes shall be D.C. electromagnetic type/thrust type. Brakes shall be designed to hold the load at any position whenever there is a current interruption, either intentionally or by main power supply failure.
Wire ropes	The wires shall be hemp cored and galvanised. Ropes shall be of regular right hand lay as per IS 2266. The rope construction shall be 6 x 37 with a factor of safety specified as per IS.
Hook block	The sheaves shall be fully encased in close fitting guards fabricated from steel plate. Smooth opening shall be provided in the guards to allow for free movement of the rope. Holes shall be provided for oil drainage. The lifting hook shall be supported on a bearing for 360 ° swivel under load.

Gears and gear box	Straight and helical spur gearing shall be used for all motions. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft. All gears shall be hardened and shall be of tempered alloy steel having metric module. Overhung gears shall not be used. All gearing shall be totally enclosed and grease lubricated.
Trolley wheels	Single flanged wheels shall be mounted in anti-friction roller bearings housed in "L" shaped bearing brackets for ease of removal during routine maintenance. Solid wheels shall be of forged/rolled steel or cast steel.
Motor for hoist and trolley	415 V, 50 Hz, heavy duty motors suitable for hoist and trolley operation, suitable for reversible motion, frequent acceleration and mechanical breaking, totally enclosed, fan cooled, wound rotor motor shall be used. Class of insulation shall be "F", with temperature rise limited that for "B". The pullout torque shall not be less than 225% of full load torque, corresponding to 40% CDF (Cycle Duration Factor of the motor). 200 switching per hour shall be considered for the selection of motors. The motors shall have the following speed ranges: a) trolley travel: 10 m/min; micro travel: 2 m/min b) hoist: 2 m/min Roller operated, resetting limit switches shall be provided for all motions. Limit switches shall be fitted to prevent over travelling and over hoisting.
Power supply	A flexible travelling cable system mounted on a retracting support system, shall be used. The conductor shall consist of insulated multi-conductor cable with permanent termination on the connection box and on the trolley. The flexible trailing cable shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail along the beam. The flexible copper cable shall be butyl rubber or EPR insulated CSP sheathed type 650/1100 V Grade.
Control	From fixed control Panel from where the entire operation area can be overlooked or from a pendant push button control block hanging on a cable from the hoist. Control voltage is 110 V from a single phase step-down transformer. The following control is possible: a) Key operated ON push button - standard green button. b) ON signal lamp - green lens. c) Emergency OFF push button - standard red button. d) Hoisting push button - standard black button. e) Lowering push button - standard yellow button. f) Micro hoisting push button - standard black button.

	g) Micro lowering push button - standard black button. h) Cross traverse forward push button - standard black button. I) Cross traverse reverse push button - standard black button. j) Micro cross traverse forward push button – standard black button. k) Micro cross traverse reverse push button – standard black button. l) Long traverse forward push button - standard black button.
Beam	The beam shall be suitable for the trolley, complete with end stops, holding down bolts and taper washers and shall be suitable for connection to the station earth. It shall be designed according to the capacity of the hoist, the beam fixation/support points, length and alignment. It shall be of galvanized mild steel. All fixation elements shall be of galvanized steel.

5.15. **Laboratory Equipment**

5.15.1. **Analytical Instruments**

5.15.1.1. **pH Metre (Digital)**

pH range	0-14 pH
Milli volt range	0 to + 1999 mV.
Accuracy	0.01 pH + 1 digit
Reproducibility	0.01 pH
Temperature compensation	0 to 1000c manual or automatic
Power supply	230 V + 10% 50 HZ
Accessories	2 No. of combined electrodes, electrode stand.

5.15.1.2. **Continuous Nephelo turbidity meter**

The on-line monitoring system shall be designed for the continuous measurement of Turbidity in water.

The full scale operating range of the system may be selected by the user from 0-4.000 to 0-4,000 NTU or from 0-10.00 to 0-10,000 PPM (mg/l) of SiO2, and the sensing system shall be capable to operate on water streams with temperature from 0 to 50 °C.

The measured Turbidity shall be displayed on a backlit liquid crystal display on the front of the instrument. The Turbidity monitor shall be suitable for water treatment plants.

The measuring method shall be Nephelometric.

A light source and a photocell shall be positioned with their optical axes 90° from each other. The emitted light is scattered by particles in the process and received by the photocell, in accordance to standard ISO 7027.

The assembly automatically shall deliver high-pressure air to the tip of the sensor to effectively blast accumulated growth from the optical lens.

The Turbidity monitor shall be supplied with the cleaner with arrangement to provide the pressure air to the sensor.

Submersible sensors shall be designed for direct immersion in the tank or flowing stream.

A Suitable length cable shall be potted into the top section of the sensor assembly, and connect directly to the Turbidity monitor.

A separate tubing connection located at the top of the sensor assembly shall be provided for connection of a 10 mtrs length of plastic tubing between the sensor and the monitor.

The Turbidity sensor assembling shall be mounted to a 1" pipe using a special mounting adapter.

The 1" pipe shall be provided with a bracket assembly to attach it to the tank handrail that holds the sensor at a slight angle in the tank.

Once installed and placed into operation, the Autoclean Turbidity sensor shall provide months of reliable Turbidity measurement in almost any application.

The sensor cleaning frequency shall be user programmable, and units shall be supplied with a default cleaning frequency of once every 24 hours.

The sensor shall have facility to increase this frequency if needed for a specific application.

The installation of the Auto-Clean Turbidity system shall be quick and simple.

It shall be designed to operate with either a retro-scatter (180°) probe or a 90° probe. The turbidity meter shall allow the user to set up measurement parameters through a user-friendly menu system displayed on the in-built 2 line alphanumeric display.

Measurements can be read directly from the display at any time or downloaded to a computer/printer through the optional RS232 output at user selectable periodic intervals.

The necessary power up arrangement should be provided to automatically power up turbidity meter to its last settings whenever external power is available.

Specifications

Range	0.0 to20,000 NTU
Display	2 line, 16-character dot matrix alphanumeric liquid crystal display.

Display language	English standard
Parameters displayed	Turbidity (NTU) - default
	Relative Turbidity Reference (NTU)
	Relative Turbidity (Turbidity - Relative Turbidity Reference NTU)
Date/Time	default
Reading	updated every 1 second
Averaging period	0.5 second or 10 seconds nominal - user selectable
Range Steps	1 <0.1 to 20NTU
	2 <1 to 200NTU
	3 <10 to 2,000NTU
	4 <100 to 20,000NTU
Resolution	1 0.02NTU
	2 0.1NTU
	3 1NTU
	4 10NTU
Repeatability	2% ± digit on all ranges
Data Logging	User set for one reading every 1 to 90 seconds or minutes. All readings stored in the Notepad.
Notepad	100 readings each with time and date
Setup procedures	Menu driven, including
	- Calibration
	- Automatic Logging
	- Analogue output range selection
	- Reference Turbidity value
	- Setting date and time.

Setup memory	Non-volatile EEPROM
Clock	Calendar clock displays date and time. Year 2000 compliant.
Analogue Output	0 - 2 volts full scale corresponding to preset measurement range. Output impedance 600 ohms nominal.
Good Laboratory Practice	All readings as well as calibration constants are stored together with the Time and Date and can be recalled at and time
Power:	
Internal	6V NiMH rechargeable battery
External	230V AC, 50 Hz Supply (with Adapter if necessary)
Power management	Automatic power down when operating from batteries after approx. 5 minutes may be selected. Automatic power up when powered externally. Low battery indication prior to shut down.
Measurement outputs	Inbuilt LCD, analogue output and optional RS232 port
RS232 Port	The RS232 port can output readings on request or at preset intervals of time from 1 to 90 seconds or minutes. The Notepad memory can also be downloaded on request. 9600 baud rate, 8 bits, no parity, 1 stop bit, Xon/Xoff protocol
Operating temperature	0 to 50°C
Operating humidity	0 to 90% RH
Storage temperature	-10 to 60°C
Case rating	IP65

5.15.1.3. **Portable Nephelo turbidity meter**

The instrument should be based on the principle of Tyndall effect. The meter should be direct reading instrument between 0-5000 Turbidity in 4 ranges for accuracy.

Range Five ranges	(1)	0 - 1 NTU

	(2)	0 - 10 NTU
	(3)	0 - 100 NTU
	(4)	0 - 1000 NTU
	(5)	0 - 5000 NTU
Display		4 - digit Digital display
Accuracy & reproducibility		Within + 2% of FSD in 0-1 & 0 - 1000 NTU (up to 500 NTU) range, + 1 % of FSD in 0-10 and 0-100 NTU ranges.
Detector		Visible range photo cell
Power Supply		230 V AC + 10%, 50 Hz.
Accessories	(a)	Flat Bottom test tubes -25 mm dia - 4 Nos.
	(b)	Cell riser
	(c)	Height shield

5.15.1.4. **Centrifuge**

The centrifuge must be compact, sturdy, dynamically balanced and be equipped with vibration dampers. The speed of rotation should be controlled with a stepless speed regulator from 0-3200 rpm and should be supplied complete with light status indicator, plug and power cord and rated to operate continuously for 30 minutes.

Maximum speed: 3200 rpm

Maximum Centrifugal force: 1600 xG

Maximum Capacity: 6x15 ml

5.15.1.5. **Dissolved Oxygen Meter**

The instrument should be capable of DO and temperature measurement in raw and treated water.

Range:	0-20 mg/l
Temperature:	0-60o C
Resolution:	DO --- 0.1 ppm
	Temp---0.1 o C
Accuracy:	DO ---- +/- 0.2 ppm
	Temp--- +/- 0.2 o C
Temperature compensation:	0 to 50 o C

Sensor:	DO --- Amperometric (gold/silver) Temp – RTD (PT –100)
Power:	220 V +/- 10 %, 50 Hz AC
Dimensions:	76 x 275 x 175 mm
Accessories:	Operation Manual, Dust cover, stirrer etc.

5.15.1.6. **Chlorine Comparator**

Specifications:-

Comparator should have capacity to measure the residual chlorine from 0.1 to 2.0 PPM. & pH from 6-8 to 8.4 (Phenol red indicator disc) by movable disc arrangement.

Accessories:-

Orthtolidine solution, test tubes, brush & cover etc. & separate movable discs, standardized for measuring Residual chlorine & pH by orthotolidine method and phenol red indicator method, respectively, should be supplied with the Comparator.

5.15.1.7. **Conductivity meter**

Should be a handy instrument for measuring conductivity of various solvents coupled to an amplifier –null detector with a meter used for balancing the bridge circuit.

Specifications

Bridge source : - 1 kHz/ 50 Hz

Null detection : - meter pointer

Conductivity Range : - 1 Micro-mhos to 106 Micro mhos 6 ranges .

Accuracy : - _+ 2%

Accessories : - unbreakable PVC cell and stand with clamp

Conductivity cell : - Approx. 1 cell constant

Power requirement : - 230 v, 50 Hz or Battery

5.15.1.8. **Jar test apparatus**

Jar testing machine with electrically operated 6 stainless steel paddle, equipped with suitable motor to give rotation from 10 to 100 rpm in all peddles. It should be provided with gear system of rotation and a speedometer to not the speed. The equipment should hold 6 glass beakers of 1 liter capacity each at a time. The arrangement of peddles should be such that they can be lifted to remove the beakers without disturbing the test liquid.

5.15.1.9. **Colony counter**

Colony counter with digital display electrically operated suitable for bacterial plate count complete with counting plates and lens etc.

5.15.1.10. **Binocular Microscope**

Binocular Research Microscope with built in illumination with variable transformer. Two pair eye pieces 5x10 and four objectives 5x, 10x, 45x and 100x, oil (springs).

5.15.1.11. **HEATING APPLIANCES**

Water still (distilled water plant)

Electrically heated with boiling chamber, lid and cooling jacket, made of stainless steel, Provided with two automatic ejection type heater, constant water level device, stout wall hanging brackets, complete with plug, cord & adapter.

Power 220 - 230 V AC

Capacity - Approx. 4.0 litres per hour

Rating of elements: - 1.5 kW each

Water bath (SEROLOGICAL)

Rectangular water bath, should be completely made of copper, heavily tinned inside and outside finished in enamel.

The cover should be chrome plated & should have 12 holes of 7.5 cm Dia. concentric rings (3 sizes of each hole) with lid. The water bath should have built in constant level arrangement and fitted with Swan type ejection electric heaters.

Dimensions	40 cm x 30 cm x 9 cm
Rating	1.5 kW
Power	230 Volt A C
Accessories	2 Meter long cord with 3 pin and adopter for power

Electric Oven

Should be doubled walled with inner chamber of Aluminium sheets and outer body made of MS sheets. The gap should be filled with good quality glass wool for proper insulation. Space for inserting thermometer control system of the accuracy of +/-10C.

Temperature range	room temperature to 2500C+/-10C
Power	220-250 V AC
Chamber size	45x45x45 cm

Autoclave

Autoclave should be vertical type, sturdy double walled construction with boiler made of stainless steel 18SWG. Sheet & easy to operate. Outer shell should be made of mild

steel finished with enamel point. The boiler & outer shall should have air insulation. Lid should be made of stainless steel plate and tightened all-round by wing nuts. Moulded, Jointless gaskets should be made of Neoprene rubber. It should be fitted with water level arrangements to indicate water position inside the boiler, pressure gauge, Air /Steam release cock, spring loaded safety valve which can be set at any selected point from 10 psi to 25 PSI +/-3 PSI and drain. ISI marked immersion type heating element heats the water steam to desired temperature & pressure, supplied complete with SS basket, cord & plug to work in 220 volts 50 cycles AC supply.

chamber size (Dia x depth)	300 x 500 mm
Load	2 kW

Incubator 2 Nos.(for bacteriological tests)

Incubator made of Aluminium sheet, inner door of glass with 3 adjustable shelves with temperature control system with accuracy of +/- 0.50C. Double wall should have proper glass wool insulation system. Thermostatically controlled.

size(WxDx H)	61x45x45 cm
operating temperature.	5^0C above ambient to 60^0C
Power	220-250 V AC

BODIncubator

Suitable to work at 230 V with automatic control heating or cooling circuits according to environmental temperature, made of mild steel wall with enamel paint, inside chamber should be anodised, adjustable shelves made of Aluminium and full inner view glass doors. Chamber capacity should be 286 litres. Temperature control device German thermostat.

Chamber size	87x57x55 cm
Temperature range	5 to 50^0C
Operating Sensitivity	+/-0.5^0C

Forced air circulation to maintain uniform temperature with dial thermometer.

MAGNETIC STIRRER WITH HOT PLATE

Magnetic stirrer with hot plate of 2 liter capacity with separate stirring & temperature control regulator for setting stirring rate & temperature complete with plug , 2 meter long cord. Adapter and Teflon paddle 1 long (Rotor 3 nos) cap. 2 liters, max . speed 1200 rpm.

5.15.1.12. **Analytical balance**

Analytical Balance complete with case, weight box, and beam of gun metal. Flat beam sprayed with colourless cellulose lacquer, edges are of best selected agates ground to optical precision case finely polished with two side doors and counterpoised front slide. Case made of teak wood having sunmica base.

Capacity	200 gm
Sensitivity	1/10 mg
Diameter of pan	3 inches slightly concave Nickel Chromium plated
Length of Beam	5 inches
Watch Glasses	2 Nos. light wt. to be provided on each of the pan
Graduation	Graduated into 100 divisions with 0 in centre

5.15.1.13. **Electronic balance**

Readability	1 mg/10 mg
Weighing capacity	60 gm/310 gm
Repeatability(s)	0.2 mg/0.5 mg
Linearity	+/-2 mg/+/-10 mg.
Stabilisation time	5 secs
Power supply	230 V AC +/- 10%, 50 Hz

Facility of piece counting, % weighing, display various weighing units, provision for attachmentof printer.

5.15.1.14. **Vacuum pump single stage (with suction flask/litre capacity)**

Electrically operated should be compact and smooth in operation with effective cooling, high water vapour tolerance and guaranteed ultimate vacuum.

Air Displacement	150 litre per minute
Ultimate vacuum	10 microns Mcleod
HP of motor	0.5 or 1/3
Pump speed	375 rpm approx.

Power supply	220/230 Volt AC

5.15.1.15. **Refrigerator**

Minimum 300 litres capacity, of reputed make.

Note:- All the aforesaid instrument should be supplied along with operation and circuit diagram manual, dust cover, 2 m long cord and plug & related accessories required for the satisfactory working of the instruments.

5.15.2. **Miscellaneous**

General

Nuts, Bolts, Studs and Washers

Nuts and bolts shall be of the best quality bright steel, machined on the shank and under the head and nut. Studs, bolts and nuts shall be electro-galvanised. Bolts shall be of accurate length so that only one thread shall show through the nut in the fully tightened conditions. Nuts and bolts shall conform to IS:1363 and IS:1367.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary.

Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel bearing stainless steel.

The Contractor shall supply all holding down, alignment levelling bolts complete with anchorages, nuts, washers and packing required to fix the plant to its foundations, bed plates, frames and other structural parts.

The Contractor shall procure and keep at site, reasonable excess quantities to cover wastage of those materials, which will be normally subject to waste during erection, commissioning and setting to work.

5.16. **Electrical Equipment**

5.16.1. **Preamble**

The specifications of electrical equipments not detailed here, shall be in accordance to the specifications given in Chapter for "Specifications for Electrical Equipment" of this Volume.

This specification covers in brief the technical requirements for the supply of equipment, materials, installation, testing and commissioning including the design / selection of the electrical systems / equipment for the Treatment Plant.

It is not the intent to specify herein all the details pertaining to the design, selection of material/equipment, procurement, manufacture, installation, testing and commissioning, however, the same shall be of high standard of engineering and shall comply to all currently applicable standards, regulations and safety codes.

The scope of the Contractor shall cover design and drawing of electrical systems, selection of the equipment / materials, procurement, expediting, inspection, packing and forwarding, delivery at site, erection, testing, commissioning, obtaining the statutory approvals, handing over the complete plant etc.

5.16.2. **LT switchgear**

5.16.2.1. **Standards**

No.	Standard	Description
1.	3247	Switchgear general requirements.
2.	8623	Factory built assemblies of switchgear & control gear for voltages up to & including 650 V.
3.	2147	Degree of protection provided by enclosure for low voltage switchgear and control gear.
4.	2551	Danger notice plates.
5.	1248	Electrical Indicating Instruments.
6.	722	AC electric meters.
7.	2705	Current transformers.
8	3156	Voltage transformers.
9.	10118	Installation and maintenance of switchgear.
10.	375	Marking and arrangement for switchgear busbars main connections and auxiliary wiring.

5.16.2.2. **Other considerations**

This section is applicable for 415V Motor control centre (MCC) for water treatment plant and other LT switch gears to be installed under the contract, if otherwise not specified.

For details of individual switchgear components refer design consideration given in tables.

Switchgear shall be made out of sheet steel in compartmentalized design and shall be suitable for bottom cable entry on rear side. The horizontal bus bar chamber shall be on the top whereas vertical bus bars shall be provided in bus alley at the front. Instead of switch fuse unit (SFU) unless other wise specifically fixed type Moulded Circuit Breaker (MCB) shall be provided.

All modules up to 630 A shall be provided with MCCB of 50 kA S.C. rating.

All modules of 800 A and above shall be provided with draw out type Air Circuit Breaker (ACB). All ACBs shall be of three pole, manually operated spring charged design.

The minimum clearance on back and sides of each switchgear shall be 1000 mm and on the front side the same shall be 1500 mm.

All MCCBs shall be provided with operating handle and door interlock.

5.16.2.3. **Technical parameters**

a)	Designation	MCC
b)	TPN busbar details	High Conductivity Aluminum grade E91E for TPN busbar, bare type, size to suit current rating.
c)	Min. clearance	Phase to phase - 25 mm Phase to earth - 20mm
d)	Earth Bus	50 x 6 GI strip for other switchgears
e)	Power freq. Withstand voltage & duration	2.5 kV RMS, 50 Hz for one minute
f)	Short time	50 kA (RMS) for 1 second
g)	Maximum temperature of bus bar	70 Deg. C
h)	ACB details	Ratings and static releases Contractor to release.
	Operating duty cycle for ACBs	0-3 min-co-3 min-co.
i)	CT details	Cast resin, bar primary type, of suitable CT ratio, 1A-1 CT burden and class of accuracy.

j)	PT details	Cast resin, single phase, wound type, 110 V PT of suitable PT ratio, burden and class for metering purpose
k)	MCCB details	Shall be with static releases, current limiting feature & aux switch for alarm / indication.
l)	Contactor details	Rating and duty shall be as per application
m)	Indicating Lamps	On, Off and Auto-trip indications on module door for each drive.
n)	Motor control supply	415/110 V, AC, 1 ph, common control transformer.
o)	Selector switch details	AS for Ammeter with R,Y,B,OFF positions and VS for Voltmeter with RY,YB,BR,OFF positions
p)	Indicating Meter details	Moving iron type, 90 deg scale, for AM & VM, Suppressed scale in case of AM for motors. AM dial range to suit CT primary current. VM dial range to suit PT primary voltage. Size 144 mm sq for incoming feeders. Size 96 mm sq for outgoing feeders. Accuracy Class 1.0.
q)	Integrating Meter details	Train gear type, calibrated for required CT-PT ratio Accuracy Class 1.0
r)	Push button details	OFF PB; momentary type, 2 NO & 2 NC contacts of 10 A
s)	Indicating lamp details	7 Watts filament type with series resistance,
t)	Control fuse details	HRC cartridge type with base & carrier Rating contractor to select
u)	Miscellaneous details	Control Wiring shall be with stranded copper conductor, PVC insulated, 650 V grade wires of 2.5

		sqmm for CT circuits and 1.5 sqmm for other circuits. Control terminals shall be of 10 A, 1100 V grade, clip on type with din rail mounting. CT terminals shall be provided with shorting link and earthing facility Control wiring shall be marked with ferrule no at both ends. All boards shall be provided with thermostat control space heater, cubicle illumination with control switches. Degree of protection for enclosure of all boards shall be of IP 52. All boards shall be applied with 2 coats of red oxide after cleaning and with final finish with enamel paint of shed no 631 as per IS-5.

5.16.2.4. **Table for selection of starter components**

i. For direct on line starting:

S.No.	Motor Rating in kW	Contactor rating in A	MCCB rating in A
1.	0.37	12	3.2
2.	0.55	12	3.2
3.	0.75	12	3.2
4.	0.9	12	3.2
5.	1.1	12	3.2
6.	1.5	12	6.3
7.	2.2	12	6.3
8.	3.7	12	12.5
9.	4.5	12	12.5
10.	5.5	12	12.5

11.	7.5	16	25
12.	9.3	25	25
13.	11.0	25	25
14.	15.0	32	50
15.	18.5	40	50
16.	22	40	50

ii. For star delta starting:

S.No.	Motor kW	Contactor			MCCB
		Line	Delta	Star	Rating
1.	30	40	40	32	100
2.	37	40	40	32	100
3.	45	70	70	40	100
4.	55	70	70	40	200
5.	75	110	110	70	200
6.	90	110	110	70	200
7.	110	200	200	110	200

5.16.2.5. **Drawing and documents required:**

- GA drawing of Panel with foundation details
  - Single line diagram
  - Schematic diagrams for various modules
  - Instruction manual for installation, operation and maintenance of various components of switchgear

5.16.3. **L.T. motors**

All LT motors to be installed in treatment plant coupled with pump; blowers; electrical hoist; motors of flash mixer; flocculator and central bridge drive shall be as per the manufacturer of the respective unit.

The motors in general shall conform to following IS codes:

No.	Standards	Description
1	IS325	Squirrel cage induction motors
2	IS:4691	Type of enclosures
3	IS:6362	Method of cooling
4	IS:4029	Testing of induction motors

5.16.3.1. **General Technical parameters**

a)	Quantity and Motor Details	*As required at various locations discussed in the document elsewhere.
b)	Type of motors	Totally enclosed fan cooled (TEFC) Squirrel cage induction motors
c)	Motor duty	Continuous, S1
d)	Supply voltage & frequency conditions	Voltage - 415 V +/- 10% Frequency - 50 Hz +/- 5% Combined variation - +/- 10%
f)	Starting Method	Star-delta for ratings > 22 kW DOL for ratings < 22 kW
i)	Earthing conductor	GI strip as per required sizes specs

5.16.4. **LT cables**

5.16.4.1. **Standards**

No.	Standard	Description
1.	1554	PVC insulated electric Cables.
2.	8130	Conductors for insulated electric cables.
3.	5831	PVC insulation and sheath of electric cables.
4.	3975	Mild steel wires, strips and tapes for armouring of cables.
5.	1753	Aluminium conductors for insulated cables.

5.16.4.2. **Other Considerations**

I) Power cable shall be of Al conductor whereas control and lighting cables shall be of Cu conductor. The minimum size of Al conductor cable shall be 6 sqmm and Cu conductor cable of 2.5 sqmm.

ii) Power cable sizing shall be based on the various de-rating factors recommended by cable manufacturer, rated current, temperature rise of conductor and voltage drop.

iii) Control cables of CTs shall be based on the VA burden of CT and relays / meters.

5.16.4.3. **Technical parameters**

LT Cables	PVC insulated, taped PVC inner sheath, 650/1100 V grade, with multi-stranded aluminum / copper conductor, armoured and overall PVC sheathed
Cable selection	Cable shall be selected considering following points Current rating of the load De-rating due to grouping of cables Voltage drop up to 5% in cable due to cable resistance De-rating factor due to ambient temperature.

5.16.4.4. **Drawings and documents required**

- Cable catalogue.

5.16.5. **Lighting Fixtures**

The specifications of lighting fixtures and the intensity of light required (Lux levels) shall be as stipulated in Chapter for "Specifications for Civil works" of this volume.. All lighting cables shall be laid in concealed conduits within the building.

5.16.6. **Cabling system**

5.16.6.1. **Installation**

The cables shall be laid in trenches, trays or conduits or buried in ground as specified in cable schedule. Cable routing given on the drawings shall be checked at site to avoid interference with structures, piping and ducting (specially with control/signal cables). Minor adjustments shall be made to suit the field conditions.

All cables shall be carefully measured and cut to the required length, leaving sufficient length for final connections to the equipment on both sides.

The contractor shall ascertain the exact requirement of cable, for a particular feeder, by measuring at site along the actual finalised route.

Cables shall be laid in complete uncut lengths from one item of equipment to another.

Cables shall be neatly arranged in the trenches/trays in such a manner, that crisscrossing is avoided and final take off to the motor / switch-gear is facilitated. LV Cables shall be laid maximum in two layers in each tray for cables up to 3 1/2 C x 95 sqmm. Arrangement of cables within the trench / tray shall be the responsibility of the contractor.

All cables shall be identified close to their termination point by cable numbers as per schedule. Cable numbers will be punched on aluminium straps, (2 mm thick), securely fastened to the cable and wrapped around it.

Underground cables shall be provided with cable markers. These posts shall be located at every 50 meters and every corner.

All temporary ends of cables shall be protected against dust and moisture to prevent damage to the insulation. While laying cables, the ends shall be taped with PVC tape.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with protective cover until the final termination to the equipment is completed.

Directly buried cable shall be laid underground in excavated cable trenches wherever required. The trenches shall be suitably designed for accommodating all the cables. Before cables are placed, the trench bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. The cable shall be covered with 150 mm of sand on top of the largest dia. cable and sand shall be lightly pressed. A protective covering of RCC tiles shall then be laid on top. The balance trench area shall then be back filled with soil, rammed and levelled.

As each cable is laid in the trench, it shall be subjected to insulation test in the presence of the Engineer-in-Charge before covering. Any cable that proves defective shall be replaced.

All wall openings shall be effectively sealed after installation of cables.

Where cables rise from trenches to motor, control station, lighting Panels etc. they shall be taken in GI pipes (rigid / flexible) for mechanical protection up to a minimum of 600 mm above grade level. The diameter of the GI pipe shall be at least 3 times the diameter of the cable.

Cable shall be carefully pulled through conduits to prevent damage.

Wherever cables are taken in conduits / pipe, the contractor shall ensure that the area of conduit / pipe is 100 % more than the cable area.

If pipe sleeves provided by Purchaser are inadequate since more cables are to be laid, then additional pipe sleeves shall be laid.

After the cables are installed and all testing is complete, conduit ends above grade level shall be plugged with suitable weatherproof plastic compound.

Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same.

At road crossings and other places where cables enter pipe sleeves an adequate bed of sand shall be given.

Cables installed above grade level shall be run in trays, exposed on walls, ceilings / structures and shall be run parallel to, or at right angles to, beams, walls or columns. The cables shall be so routed that they will not be subjected to heat.

Cables running along structures will be clamped by means of GI saddles and saddle bars at a spacing of 300 mm.

Cable carrier system i.e. site fabricated ladder type cable trays and supporting steel shall be painted before laying of cables. Painting shall have two coats of red oxide and one coat of Aluminum paint.

For all outdoor buried cables a 3 meter diameter loop shall be provided at both ends before termination.

5.16.6.2. **Termination:**

All PVC cables shall be terminated at the equipment/Panel by means of double compression type brass glands and tinned copper lugs.

Power cable cores shall be identified with red, yellow and blue PVC tapes.

In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per inter-connection diagrams, to be furnished to the contractor.

The cable shall be taken through adequate size gland inside the Panel or any other electrical equipment.

Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping.

5.16.6.3. **Testing of cables**

Before energizing, the insulation resistance shall be measured from phase to phase and phase to ground.

5.16.7. **Earthing system**

All the material required for the earthing system shall be supplied and installed by the contractor. The main grid conductor shall be hot dip GI strip of 50 x 6-mm size.

Earthing layouts shall be prepared by the contractor. All the material required for making earthing stations, such as electrode, charcoal, salt etc. shall be supplied by the contractor. Excavation and refilling for laying of earth strip and for earth pit shall also be in contractor's scope.

The entire earthing system shall fully comply with Indian electricity act and rules. The contractor shall carry out any changes desired by the electrical inspector, in order to make the installation conform to I.E. Rules.

The main earth grid shall be laid at a depth of 1000 mm below Grade level. In trenches, earth strip shall be laid along the trench. It shall be protected against mechanical damage. Joints and tappings in the main earth grid shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints except the equipment end shall be welded. All joints buried in ground shall be suitably protected by giving two coats of bitumen and covering with hessian tape.

1. Conduits in which cables have been installed shall be bonded and earthed. Cablearmours shall be earthed at both ends.
2. Earth pipe electrodes shall be installed as per IS 3043. Their location shall be marked on earth pit chamber covers.
3. The electrodes shall be tested for earth resistance by means of standard earth tester.
4. A disconnecting facility shall be provided for individual earth pit to check earthresistance.
5. All electrical equipment above 230 V shall be earthed at two points and equipmentbelow 230 V shall be earthed at one point.
6. Conductor size for connections to various equipment shall be as per the table asfollows: -

Equipment		Conductor Size
Motors	Up to 11kW 11 kW up to 22 kW 22 kW up to 37.5 kW 37.5 kW to 90 kW 90 kW to 200 kW Above 200 kW	8 SWG GI wire 4 SWG GI wire 25 x 3 mm GI flat 25 x 6 mm GI flat 40 x 6 mm GI flat 50 x 6 mm GI flat

MCC/PDB		50 x 6 mm GI flat
Local control station, street light pole & its junction box		8 SWG GI wire
Main earth grid		50 x 6 mm GI flat
SLDB		32 x 6 mm GI flat
Lighting Panel		25 x 3 mm GI flat
Indoor fixtures		14 SWG GI wire

All paint, scale etc. shall be removed before earthing connections are made.

Anchor bolts or fixing bolts shall not be used for earthing connections.

5.16.8. **Earthing station**

The pipe electrode of 40 mm dia x 3000 mm long GI pipe shall be provided. Salt and coke shall be filled in layers of 25 mm. up to one meter and balance shall be filled with loose soil. However, care shall be taken that the earth pit does not sink. The brick chamber (600 x 600) shall be made 75 mm above FGL and shall have heavy duty cast iron frame and hinged cover at top for inspection. A 40-mm NB GI Watering pipe shall be provided in the pit.

5.16.9. **Testing**

Lighting installation shall be tested as per the instructions of the Engineer-in-Charge and shall include but not be limited to the following:-

- Measure the insulation resistance of each circuit without the lamps being in place and it should not be less than 1-M ohms to earth.
- Current and voltage of all the phases shall be measured at the lighting Panel bus barswith all the circuits switched on with lamps, if required, load shall be rebalanced on thethree phases.
- Check the earth continuity for all socket outlets. A fixed relative position of the phaseand neutral connections inside the socket shall be established for all sockets.
- After inserting all the lamps and switching on all circuits, minimum and maximumillumination level should measured in the area.

5.16.10. **Miscellaneous**

5.16.10.1. **Cable glands and lugs**

All cable glands shall be made out of brass and shall be of double compression type.

All cable lugs shall be of tinned copper, crimping type.

5.16.10.2. **Cable trays**

Cable carrier system shall comprise of site fabricated ladder type cable trays made out of structural steel and painted duly with two coats of red oxide and a final coat of enamelpaint. The construction of the cable trays shall be as per the site requirement andgenerally in line with the drawing enclosed.

5.16.10.3. **Civil works**

All civil / structural works, required for electrical installation is included in the contractor's scope. However some of the major items are listed below

Foundations for Lighting Masts / poles.

Road Crossings by RCC Pipes

- Excavation, cable protection tiles, sand filling, back filling etc. for directly buried cables and earthing conductors.

Any other minor civil works required such as making openings in wall, floor etc.

Built up trenches for indoor cabling.

All openings made by the contractor for laying of conduit / cable / earthing strip etc. shall be made good at no extra cost.

5.16.10.4. **Local PB Stations**

a) Construction	Outdoor type weatherproof
b) Push Buttons	On, Off

5.17. **Instrumentation and Control Systems**

The requirements of the Instrumentation, Automation and Control for the Treatment Plant are stipulated in Chapter "Specifications for Instrumentation" of this volume. The requirement of works and their specifications shall be in accordance to the stipulations in the Chapter.

5.17.1. **Signal and Control Cables**

All digital signal cables, control cables and 240V AC power supply cables shall be of 1.5 sq. mm solid copper conductor, single or multi core, armoured type (CYWY) of 650/1100V grade.

All analog signal cables shall be of 1.5 sq. mm stranded copper conductor, single or multi twisted pairs, screened type.

All instrumentation cables viz. power, digital signal and analog signal shall be laid in GI conduit. The cross sectional area of the conduit shall be minimum 2.5 to 3 times the cross sectional area of cables to be laid through.

Minimum clearance of 300 mm shall be kept between signal cables and electrical power cables when running parallel. Crossing or overlaying of the cables shall be avoided. Sharp bends or zigzag laying of the cables shall be avoided at all the places. All signal cables shall have shield earthing at control Panel end only.

Double compression type brass cable glands shall be provided for all the cables while terminating at instrument junction box and control Panel.

Wherever there are cable trays, they shall be provided with proper supports and cables shall be clamped in the trays properly and no cable shall be kept loose or hanging.

5.17.2. **Junction Box (JB)**

Weatherproof junction boxes shall be provided for all signal and control cables wherever required. All junction boxes shall be mounted properly and shall have chrome-plated rail mounting type terminal block arrangement.

Wherever possible use of instrument power supply junction boxes as well as signal junction boxes shall be made to enable use of multi-core as well as multi-pair cables respectively between the control Panel to JBS.

From JB onward the individual cables to field equipment shall be laid through flexible GI conduit.

The general arrangement of power supplies JB and signal JB shall be similar to the sketch enclosed. Minimum 3 circuits in case of power JB and 25% terminals in case of power shall be provided for future use, if required.

All junction boxes shall be of weatherproof type (IP65) as per IS: 2147.

5.17.3. **Filter Operating Consoles:**

It shall be a Panel mounted with instrumentation elaborated in the section on Filter Beds. All instruments will be of flush mounting. It shall be constructed in MS Sheet of minimum 2 mm thickness painted with Epoxy Paint of approved colour. The Panel shall have instruments mounted for viewing and operation at an appropriate level. The Panel shall have no sharp edges and the drawing of same shall be got approved from USCL before manufacture.

5.17.4. **Local control Panels**

Local control Panels wherever required shall be provided standard vertical or slanted Panel type only depending upon the number of components viz. control switches, indicating lamps, meters etc.

Sheet of local Panel shall be of MS and thickness not less than 2 mm.

Local control Panel after having the pre-painting treatment and two coats of red oxide shall be painted with final paint shade of 631 as per IS: 5. The control Panel shall have bottom entry for cables, hinged type lockable door arrangement and easy access for wiring. Mounting arrangement for the control Panel shall be suitable for the application and location and easily accessible for the operator.

Site Calibration

All field instruments shall be calibrated at site under supervision of supplier's Engineer. Standard calibration procedures shall be followed for calibration. All reference equipment such as pressure gauges, scales etc. shall be certified from authorized / approved agency. All such certification shall be in the scope of contractor.

For all instruments standard calibration documentation shall be prepared at the time of calibration.

All Calibration and recalibration shall be performed in the presence of the Engineer-in-Charge or his representative till handing over of the plant shall be done by the contractor.

5.17.5. **Loop Drawings**

Loop drawings shall be prepared for all control loops and field instruments. Any change in the loop drawings at the time of installation as per requirement at site shall be documented and approved by the Engineer-in-Charge before execution.

5.17.6. **Checks and Loop Checking**

Cable continuity shall be checked before cable laying and after cable termination for all the instruments. Loop checking shall be conducted for all the analogue and digital loops before system testing. Any damage or fault shall be immediately located and rectified. All the instruments and control Panel shall be isolated from the power supply while cable laying and termination. Each instrument shall be checked for its functions before putting them into operation. All control loops shall be checked in manual mode first and then they will be put in to the auto loops.

All instruments shall be provided with proper earthing.

5.17.7. **Documentation**

Supplier shall provide following set of documents and drawings

1. Instrumentation Schedule
2. Instrument schedule
3. Instrumentation Cable schedule
4. Loop drawings
5. Technical Parameters for each instrument (Data Sheet)
6. Control Panel drawings (GA Drawing & Control room layout) and control Panel wiring
7. P&I Diagram for Water Treatment Plant
8. Equipment layout and plant layout indicating location of each instrument
9. Calibration and test reports for each instrument (shop and site)
10. Pre-commissioning check list for equipment and instruments

5.18. Civil Works

5.18.1. General

The civil works shall be carried out as per specifications defined in Chapter for Technical Specifications of Civil Works of this volume in accordance with the Indian Standard. In case of any variation between the specifications, the specifications given in document shall prevail.

All masonry shall be either in stone or bricks of class designation 100 in 1:4 cement sand mortar.

The thickness of the external walls and load bearing walls shall not be less than 30 cms for stone masonry and 23 cm for brick masonry. The partition walls shall not be less than half brick thickness.

The general requirement of material, specifications, sampling of materials, standards to be followed & testing criteria shall be as per provisions laid down in chapter for "Technical Specifications of Civil Works" of this volume.

5.18.2. Technical Requirement of building and site development Works

S. No.	Particulars	Specification to be adopted
1.	Damp Proofing Course	75 mm thick Cement Concrete
2.	Exterior Walls	
(a)	Below G. L.	Stone masonry in CM 1:4 up to G. L.

(b)	Above G. L.	Brick Masonry / stone masonry Wall in C. M. 1:4			
3.	Interior Walls				
(a)	Below G. L.	Stone masonry up to G. L.			
(b)	Above G. L.	Brick Masonry / stone masonry Wall in C. M. 1:4			
5.	Partition Walls	Half Brick in C. M. 1:4 reinforced properly			
6.	Roofing	RCC / For flat roofs treatment shall be provided with brick bat coba & finishing coat of 25 mm thickness in CM 1:4 with Water Proofing Treatment			
7.	Plaster	Cement Mortar 1:4			
8.	Exterior Finish	Stone grit wash in front face and side walls & plaster 1:4 with water proofing cement paint on side & back.			
9.	Interior Finish	*Floor*	*Wall Finish*	*Doors*	
	Unit			*Frame*	*Shutter*
	Storage space for Chemicals	CCH	CW	PSDF	FD
	Staff Toilet	KS	Tiles upto LL	PSDF	PVC
	Lobby	KS with decorative marble finish	AD	AL	ALG
	Staircase	KS	CW	-	
	Chlorinator room	TPT	CW	PSDF	FD
	Chlorination control room	TPT	CW	PSDF	FD
	Alum and lime dosing room	TPT	CW	PSDF	FD
	Filter control gal-lery	DDS	AD	PSDF	FD
	Main Filter control room	KS with decorative marble finish	AD	PSDF	FD
	Backwash pumps and compressor room with sump	CCH	AD	PSDF	FD
	Filter Pipe gallery	CC Flooring	AD	PSDF	FD
	Office	KS	AD	PSDF	FD
	Archive	KS	CW	PSDF	FD
	Laboratory	KS	AD	PSDF	FD
10.	Sanitary				
	W. C.	As per directions of Engineer in Charge Orissa Pan / European			
	Urinals	Flat Back size 610x400x80 with 25 mm G. I. Waste pipe			
	Flushing Cistern	Low Level 10 litre Capacity			

	Wash Basin	Flat Back 550x400 mm

Abbreviations used in above table are:

PSDF	Pressed Steel Door Frame	CW	Colour Wash	KS	Kota Stone
AL	Aluminium Box Section	PVC	Poly Vinyle chlride	CC	Cement Concrete 50 mm thick
FD	Flush Door (Solid Core type)	ALG	Aluminium Glazed Panel	AD	Acrylic Distemper
LL	Lintel Level				
CCH	Cement Concrete with Hardener	RS	Rolling Shutter		

5.18.3. **Doors and windows:**

As a general guideline the total area of doors and windows shall be not less than about 25 % of the floor area.

Doors in dangerous areas (chemical house, main distribution Panel room) shall open to the outside. The chlorinator room shall have two doors.

All outer doors and those of dangerous areas shall have a self-closing device.

The types and locations of the doors and windows shall be approved by the Engineer in Charge.

All the external walls shall have aluminum section glazed window as per specification provided in Chapter of specifications of civil works. The other walls may have steel glazed windows shutters of standard rolled steel section joints mitered and welded with steel lugs 13 * 3 mm, 10 cm, long with fixed wire gauge of 14 mesh * 24 gauge to the metal frame of rolled section by metal beading 20 * 3 with suitable screw at not exceeding 150 mm distance and square bars or other flat welded, embedded in cement concrete block 15 *10* 10 cm of 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) or with wooden plugs and screws or with fixing clips or with bolts and nuts as required including providing and fixing of plain glass panes 4 mm thick with glazing clips and special metal sash putty of approved make or metal beading with screws complete including priming coat of approved steel primer, partly fixed and partly openable [Fixed area not to exceed 35%]

5.18.4. **Sanitation Facilities:**

A lavatory should be provided near the laboratory and control room. It should have an area of about 5.00 sq. m. It should be equipped with Indian type water closet, urinal,

and flushing cistern for WC, washbasin, mirror, toilet shelf etc. The disposal (in septic tank soak pit etc.) should be made at least 15m away from the main building. The disposal system is part of the contract.

5.18.5. **Walkways and access stairs**

Unless otherwise specified all units shall be accessible by concrete walkways of a width of 1.0 m. The walkways shall have railings of 1.0 m of galvanized steel tubes of diameters 32 (pillars and upper railing) and 25 mm (lower railing). The walkways shall be accessible from the upper floor of the control building and by means of 1m wide stairs at suitable places (filters, mixing chamber). Walkways shall link the following units:

- around the clariflocculators;
- along the feed channel of the filters;
- from filters to the mixing chamber;
- from mixing chamber to each clariflocculator;
- from the mixing chamber to the inlet chamber along the measuring channel;

In addition walkways shall be provided along the solution tanks in the chemical house.

5.18.6. **Internal water supply**

The water supply of the whole treatment plant shall have two circuits:

5.18.6.1. **Process water**

Process water shall be supplied from the backwash water reservoir for:

- Back-washing of the filters
- Preparation of the chemical solutions
- Injectors of the chlorinators
- Sprinkler system in the chlorine drum storage area
- Supply points for desert coolers and cooling system
- Flush toilets

5.18.6.2. **Drinking water**

The contractor shall provide the drinking water facilities within the campus. These shall be provided in laboratory, staff room, workshop, and chemical house.

5.18.7. **Finishing**

5.18.7.1. **Painting of metallic surfaces**

If not otherwise stated metallic surfaces shall receive one initial coat in the manufacturer's workshop. After arrival of the equipment on site, the same shall be

inspected and damaged portions shall be cleaned and given the primer and under coat of similar paint. After erection all metal work shall be painted as follows:

Painting of metallic surfaces

All mild steel railing, mild steel ladders, pipes for water supply, grit iron plates	Galvanization, chromate primer, and two coats of approved oil paints, finishing coat of approved oil based paint of approved shades.
Submerged metallic parts and their projections above water level	Two coats of bituminous paint
Metal parts above water level or in dry places	Primer of red oxide, two under coats and one finishing coat of an approved oil based paint and of approved shades
All indoor fixtures, instruments and similar equipment on Panels etc.	Chromium or copper nickel plating

Coating of the pipes and the plant equipment is to be provided according to the specifications and following the colour code.

5.18.7.2. **Final Finishing:**

The contractor will ensure that the entire building alongwith all its installations are in a finished and in new and fully operative condition when handed over. He shall have repaired and remove all signs of damage that might have been done during the course of installation and fixing of equipment. He shall also see that the entire exterior has been finished properly and the entire site is cleared of all extra construction material, debris and excavated soil. This shall have to be done to the satisfaction of the engineer in charge.

5.19. **Miscellaneous requirements**

5.19.1. **Name plates, signboards, nomenclature**

Each item of the plant shall have permanently attached to it in a conspicuous position a name plate, on which shall be engraved or stamped the manufacturer's name, type and serial number, manufacturing year, details of the design capacity etc. Such labels shall be of non-hygroscopic material to be approved by the Engineer in Charge.

Near or on each item of the plant a plate with the name and nomenclature (code) of the item according to the project nomenclature shall be fixed. It shall be visible from a distance of several metres.

The Contractor shall also provide bilingual signboards and instruction tables of durable material throughout the plant for the purposes of operation, maintenance and security:

- Danger and caution signs (English and local language)
- Preventive maintenance schedules (local language)
- Operation instructions (local language)
- Unit names (English and local language)
- Nameplates at the doors to the units (English and local language)

Signboards and plates shall be appropriately sized in relation to the relevant item and its surroundings. Details of the proposed inscription, size, material and colours shall be submitted to the Engineer in Charge for approval before any tables are manufactured. They shall be compatible with the instructions in the operation manual

All cables shall be provided with clip-on identification numbers on both ends and at all terminations in between, for identification. The nomenclature shall correspond to the electrical as-built drawings.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 6. Specifications for Civil Work

6.1. Civil Works

6.1.1. General

This part of the specification covers the design loads to be considered, specifications of material and workmanship for the civil works. Material used and workmanship for the civil works of campus development, repair/new works of buildings, civil works associated with pipeline laying etc. to be done under the contract will adhere to the provisions laid down in this chapter.

For materials used other than those specified, the material must conform to the requirement of respective Indian Standards. The contractor shall get prior approval of the materials proposed to be used under the contract as per the provisions of Special Conditions of Contract, from the Engineer-in-Charge.

6.1.2. Design Considerations:

6.1.2.1. Design Submissions

The contractor shall be responsible for the safety of structures, correctness of design and drawings, even after the approval of the same by Engineer-in-Charge.

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer-in-charge for approval. The contractor shall submit the detailed design & drawing with step wise calculations in excel sheet. Formulas for calculation should be clearly mention and nothing should be blocked or hidden. The contractor shall submit the detailed design & drawing with step wise calculations. Formulas for calculation should be clearly mention and nothing should be blocked or hidden. Structural design & drawing of Intake/CWR/GLSR/WTP/PH etc, **shall be got vetted from MNIT Jaipur/ MBM Engg College, Jodhpur/ Kota Engineering College/ BITS Pilani/any IIT** and such charges shall be borne by the contractor. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer-in-charge.

The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed.

The following shall be the procedure for submission and approval of detailed design and execution drawings:

1. The Contractor shall submit three copies of designs/drawings within 4 weeks from the date of work order, to the Engineer in Charge. All the drawings are to be signed by the design engineer and Contractor or his authorized representatives.

2. The contractor shall submit the detailed design & drawing with step wise calculations in excel sheet. Formulas for calculation should be clearly mention and nothing should be blocked or hidden. The contractor shall submit the detailed design & drawing with step wise calculations. Formulas for calculation should be clearly mention and nothing should be blocked or hidden. Structural

design & drawing of Intake/CWR/GLSR/WTP/PH etc, shall be got vetted from MNIT Jaipur/ MBM Engg College/ Kota Engineering College/ BITS Pilani/any IIT/ Govt. Engineering Colleges/ other Government institutions and such charges shall be borne by the contractor

3. In case the designs/drawings are not found fit for approval, the Engineer in Charge will mark the comments on them and return two copies to the Contractor within 2 weeks. In such case the Contractor shall resubmit the revised designs/drawings, with the revisions clearly indicated and numbered, within two weeks as per sub-Clause (a) above and the same shall be repeated till drawings are finally approved as per sub-clause (b) above.

4. The final approval of general arrangements, design and drawing shall be given by competent authority who reserves the right of making any correction in the design and drawing.

5. On receipt of approved designs/drawings as per sub-clause (b) above, the Contractor shall submit six (6) additional Linen bound copies and reproducible of the approved designs/drawings to the department for reference and records, within one week of approval. The final design and drawing will then be the property of department.

No designs/drawings with corrections made after taking the prints will be accepted.

The approval of drawings/designs by the Engineer in Charge shall not relieve the Contractor of his responsibility in terms of the Contract for soundness of the designs. He shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars have been approved by the Engineer in Charge or not, provided that such discrepancies/errors or omissions be not due to in accurate information or particulars furnished in writing to the Contractor by the department. The department shall be responsible for drawings and information supplied by it and for the details of special work specified by it. The Contractor shall be responsible for the structural safety of all the components of the work, stability and water tightness of the structure.

The drawing provided by the department shall got rectified and checked by the contractor on his own account for its soundness. He shall be responsible for any discrepancies, errors or omissions in the design/drawings and other particulars supplied to him. The contractor shall be responsible for the structural safety of all the components of the work, stability and water tightness of the structure.

6.1.2.2. **Design Standards**

All designs shall be based on the latest Indian Standard (I.S.) Specifications or Codes of Practice unless otherwise specified. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Engineer-in-charge. In case

of any variation or contradiction between the provisions of the I.S. Standards or Codes and the specifications given along with the submitted tender document, the provision given in this specification shall be followed.

6.1.2.3. **Design Life**

The design life of all structures and buildings shall be 60 years.

6.1.2.4. **Design Loading**

All buildings and structures shall be designed to resist the worst combination of the following loads/ stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads:

6.1.3. **Dead Load**

This shall comprises all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipments and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included.

6.1.4. **Live Load**

Live loads shall be in general as per I.S. 875. However, the following minimum loads shall be considered in the design of structures:

i. Live load on roofs : 2.00 kN/m2

ii. Live load on floors supporting equipment such as : 10.00 kN/m2

pumps, blowers, compressors, valves etc.

iii. Live load on all other floors walkways, stairways and : 5.00 kN/m2 platforms

In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer-in-charge prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection/ construction shall be considered and shall be partial or full whichever causes the most critical condition.

6.1.5. **Wind Load**

Wind loads shall be as per I.S. 875. Part 3

6.1.6. **Earthquake Load**

This shall be computed as per I.S. 1893 taking into consideration soil foundation system, importance factor appropriate to the type of structure basic horizontal seismic coefficient/ seismic zone factor & average acceleration coefficient.

6.1.7. **Dynamic Load**

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, traveling cranes, etc. shall be considered in the design of structures

6.1.7.1. **Joints**

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 40 m shall be provided in walls, floors and roof slabs of water retaining structures.

The positions of construction joints should be specified by the designer & indicated on the drawings. If there is a need on site to revise any specified position or to have additional joints, the proposed positions should be agreed with the designer.

The concrete at the joint should be bounded with that subsequently placed against it, without provision for relative movement between the two concrete should not be allowed to run to a feather edge & vertical joints should be formed against stop edges.

Expansion joints for non liquid retaining structures shall be provided as per IS 3414.

6.1.8. **Foundations**

1. The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per IS 1904.

2. Bearing capacity of soil shall be determined as per IS : 6403.

3. Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

4. A structure subjected to groundwater pressure shall be designed to resist floatation. The dead weight of empty structure shall provide a factor of safety of 1.2 against uplift during construction and service.

5. Where there is level difference between the natural ground level and the foundations of structure or floor slabs, this difference shall be filled up in the following ways.

a. In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm) and the level difference shall be made up by compacted backfill as per specifications. However the thickness of each layer shall not exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction.

b. In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete not weaker than M 10.

6. If pile foundations are used, the contractor shall conduct the initial routine test as per IS 2911 at his own cost, to determine the safe load bearing capacity of piles.

6.1.9. **Design Requirements**

The following are the design requirements for all reinforced or plain concrete structures.

(i) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M10 unless otherwise specified.

(ii) Liquid Retaining Structures : All water retaining structures like CWR, GLSR, intake well along with WTP and pump house shall be constructed with M-30 grade of concrete with a maximum 20 mm aggregate size for all other structural members.

(iii) All structural reinforced concrete for other structures like chambers, buildings, CWT, PSP etc. shall be of a minimum M25 grade with a maximum 40 mm aggregate size for footings and with a maximum 20 mm aggregate size for all other structural members.

(iv) The reinforced concrete for water retaining structures shall have a minimum cement content of 320 kg/m^3 with a maximum 20 mm size aggregate.

(v) The minimum reinforcement in walls, floors and roofs in each of two directions of right angles within each surface zone shall be as per 7.1 of IS: 3370 part 2.

(vi) The nominal cover of concrete for all steel, including stirrups, links, sheathing and spacers shall be as per 7.2 of IS : 3370 Part 2.

(vii) All buildings shall be provided with damp proofing for basement and floors and water proofing for roofs.

(viii) All pipes and conduits laid below the structural plinth and roadwork's shall be embedded in reinforced concrete of grade M15 of minimum thickness 100 mm.

(ix) Suitable admixtures may be used with the approval of engineer in charge.

(x) Construction of floors and walls of Liquid Retaining structures shall be as per 9.4 & 9.5 of IS : 3370 Part 1.

6.1.10. **Requirements For Construction of RCC Reservoirs**

6.1.10.1. **General**

The RCC reservoirs are to be constructed as per the type; & size detailed in the "Scope of Work" defined in this Volume II of tender document.

The contractor shall submit detailed general arrangement drawings, structural drawings and design of each structure for the approval of Engineer in charge. The designs shall adhere to the provisions given in this chapter.

The construction of reservoirs shall be carried out in accordance with the specifications mentioned herein and relevant IS amended upto date. The general arrangement drawings of the piping system and other drawings like layout plan of site, structural drawings and designs, working drawings, etc shall be submitted by the contractor for approval of the department prior to start of work. In cases where the specifications given below are silent about any aspects in respect of any item, the work shall be carried out as per the relevant IS code of practice in the latest version and as per sound engineering practice as decided by the Engineer in Charge.

6.1.10.2. **Preparatory Works**

The Contractor shall provide and maintain a benchmark with a level at a location approved by the Engineer in Charge at each reservoir construction sites. All levels shall be deemed to refer to that benchmark. The Contractor may establish other secondary benchmarks on the site.

6.1.10.3. **Soil & Geo Technical Investigation**

SBC tests shall be got done through an approved agency wherever the strata on which foundation is to be laid is not rocky. For foundations to be laid on sandy strata, the structural design and reinforcement drawings shall be prepared assuming maximum SBC of soil as 12 T/Sqm even if the SBC testing is found to be 12 T/Sqm or more at foundation depth. If the SBC testing is found to be less than 12 T/Sqm at foundation depth, the structure shall be designed on the basis of actual SBC found on testing for which no extra payment will be made to contractor.

For foundations to be laid on rocky strata, with firm rocks the SBC shall be taken as 18 T/Sqm.

6.1.10.4. **Material of Construction**

The building material to be used shall be as per the specifications given in this chapter. The pipes & specials to be used shall be as per the specifications given in Chapter 3 for Pipes for MS pipes and shall be ISI Marked as per IS 1536/1538 for cast iron pipes and ISI Marked as per IS 8329: 2000 for DI pipes. The valves, instruments, etc. shall be as per the specifications given in other chapters of this volume II respectively containing specifications of Valves and Instrumentation.

6.1.11. **Design Considerations for Reservoirs**

6.1.11.1. **GENERAL PRINCIPLES:**

a) Maximum height of live storage in cylindrical portion shall be 5.0 meters.
b) Height of dome shall be vary from 1/6th to 1/7th of span of dome.

c) Free board shall be kept as 0.3 meters (i.e. height above maximum water level and top of ring beam).

6.1.11.2. **Considerations for CWR -**

All underground or partly underground liquid containing structures shall be designed for the following conditions :

a) liquid depth up to full height of wall : no relief due to soil pressure from outside to be considered;

b) structure empty (i.e. empty of liquid, any material, etc.) : earth pressure and surcharge pressure wherever applicable, to be considered as per site conditions;

c) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall;

d) partition wall between two compartments : to be designed as one compartment empty and other full;

e) structures shall be designed for uplift in empty conditions with the water table as per site conditions with due variation on higher side. The possible flooding levels due to local drainage system shall be accounted while designing the structures.

f) underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The design shall be such that the minimum gravity weight exceeds the uplift pressure at least by 20%.

6.1.11.3. **Loads**

All loads shall be considered as per the provisions of IS 875 and other references as defined in this chapter. The design shall be suitable for the worst possible conditions of loading during construction and operation.

6.1.11.4. **Concrete Grade, cover, minimum cement content and thickness**

Grade of concrete to be used for the reservoirs shall be M-30 as per the provisions of IS 456 for severe environmental exposure conditions. The minimum cement content for reservoir members shall be 360 Kg/cum. For other works such as plinth protection etc.., the minimum cement content shall be as per the respective codes. Minimum cover as prescribed in IS 456 shall be provided. The minimum thickness of reservoir members shall be in accordance to the provisions of IS 456 and IS 3370. However the following minimum thicknesses shall be provided for different reinforced concrete members, irrespective of design thicknesses, are as follows:

Walls for liquid retaining structures	150 mm
Flat Top Roof slabs for GLR /CWR	150 mm
Spherical Dome of RCC reservoirs	125 mm
Bottom slabs and roof slabs for GLR /CWR	150 mm

	Floor slabs including roof slabs, walkways, canopy slabs	100 mm
	Wall of cables/ pipe trenches, underground pits etc.	100 mm
	Column footings	300 mm
	Parapets, Chajjas	100 mm
	Pre-Cast trench cover	75 mm
	Free board depth to be provided	300mm
	Dead storage depth	100mm
	Thickness of lean concrete below foundation	100mm
	Age factor shall not be more than	1(one)

6.1.11.5. **Final Finishing**

The contractor will ensure that the entire structure along with all its installations are in a finished and in new and fully operative condition when handed over, after the O & M period is over. He shall have repaired and removed all signs of damage that might have been done during the course of installation and fixing of equipment. He shall also see that all the exterior has been finished properly and the entire site is cleared of all extra construction material, debris and excavated soil. This shall have to be done to the satisfaction of the Engineer in Charge.

6.1.12. **Miscellaneous Items of Reservoirs**

6.1.12.1. **Puddle collars**

Puddle collars shall be used for connecting the inlet, outlet, overflow & washout pipes to the reservoir. All puddles shall be fixed at right angle to the RCC wall during casting of wall. All puddle collars shall be of DI/C.I. The minimum length shall be at least 100 mm more than the total finished thickness of the walls and size of the puddle collars shall be equal to the size of the outlet pipe.

6.1.12.2. **Ladder**

The ladders in reservoirs from balcony to top dome shall be of iron and top dome to inside platform and from platform to bottom dome in the container shall be of anodized (20 to 25 micron)aluminum ladder of 450 mm wide with 2 nos. rectangular section of 65X35X3 mm vertical pose and 25 mm bars steps as 300 mm center to center complete in all respect.

6.1.12.3. **Railing**

Hand railing shall be provided along the stairs. Hand railing around the platforms, Balcony, stairs and landings shall be consisting of 25mm diameter medium B class GI pipes in two rows (one at the top and other at middle level) and 750mm high vertical post 50x50x6 mm angle iron @ 300mm centre to centre (At least two vertical angles are to be provided wherever distance is less) with all accessories like elbows, tees etc. including welding, threading and embedding in cement concrete floor. Railing shall be protected against corrosion after welding. The pipe shall pass through hole in the vertical angle.

6.1.12.4. **Water level indicator**

Water level indicator shall be provided for each reservoir to be constructed in this contract. Water level indicator consisting of an approved copper float and an iron counter weight connected to a flexible stainless steel wire 4mm thick passing over pulley 70mm diameter. The pulleys shall be properly fixed in concrete and should have a guide so that the wire does not slip from the pulley.

The scale shall be calibrated in centimeters and should consist of M.S. sheet 20 gauge fixed over wooden plank with an M.S. angle iron frame of 35mm x 35mm x 5mm and painted with white enamel base, letters in black and red. The scale shall be located and fixed with RCC vertical wall.

6.1.12.5. **Float Valve**

Float valve made of copper ball with suitable lever arrangement as per approved drawing shall be installed over inlet pipe in the reservoir so that flow is stopped when tank is filled to its full capacity. The various dimensions of the float valve arrangement shall be designed as per flow in the inlet pipe.

6.1.12.6. **Slogan and logo**

The contractor shall paint on the vertical wall of the tank portion by using 3 coats of plastic emulsion paint of shade as approved by engineer in charge to form a base for writing the slogan. The shade for painting the slogan will be approved and directed by Engineer in Charge. The logo should indicate the name of the project, name of the village and the capacity of the reservoir. The slogan shall be as directed by the Engineer-in-charge.

6.1.12.7. **Pipe Clamp**

The clamp shall be 6mm thick 50mm wide MS flat fixed on pipe & column.

6.1.12.8. **Man Hole Cover**

Square manhole cover 600X600 mm shall be provided. The cover shall be made of 5 mm thick MS flat. The frame shall be made of MS angle 50*50*6. The cover shall be connected to this frame by using two nos. strung hinges. Locking arrangement shall be provided.

6.1.12.9. **PVC water stops for construction joints in vertical wall**

PVC Water stopps shall be used as construction joints in vertical wall as per IS 3370 Part-I 1965. Overlaps in sheets shall be 150 mm.

6.1.12.10. **Plinth protection**

Plinth protection works for OHSR, CWR and GLR is to be provided all around each reservoir in a 1 m circular strip. It shall consist of laying lean concrete 100 mm thick in M10, over compacted soil. Over the lean concrete brick on edge flooring or RR stone flooring in 1:4 cement sand mortar shall be provided. Along this plinth protection provision of toe wall of M15 grade cement concrete 150 mm wide over the base of lean concrete of M10 shall be provided. Side slope of plinth protection shall be 1 in 50 outward & peripheral slope should be 1 in 500.

Plinth protection works to be constructed below the OH Service Reservoir, shall be extended up to 1m from fall of balcony or edge of raft slab, whichever is more, all around service reservoir. It shall consist of laying lean concrete 100 mm thick in M10, over compacted soil.

The minimum free space between plinth protection and the first bracing of the OHSR shall be 1.60 meters.

6.1.13. **Testing for water tightness**

The contractor shall carry out a water tightness test as per IS;3370 for the maximum water head condition i.e. with the water standing at full supply level.

The water tightness test of water retaining structure like CWR, GLSR, Flocculator etc shall be done prior to inside & out side painting on the structure. Inside & out side paint of the structure shall be applied only after successful completion of water tightness test & prior approval of competent authority.

All cost of testing shall be borne by the contractor. This test shall be carried out in accordance with the procedure given below ;

- For water tightness test, before the filling operations are started, the reservoirs shall be jointly inspected by the Engineer in Charge and the representative of the Contractor and condition of surfaces of wall, construction joints etc. shall be inspected and noted and it shall be ensured that jointing material filled in the joints is in position and all openings are closed. The contractor shall make necessary arrangement for ventilation and lighting of reservoir by way of flood lights, circulators etc. for carrying out proper inspection of surfaces and internal conditions if so desired by the Engineer in Charge.

- The water retaining structures shall be filled with water gradually at the rate not exceeding 30 cm. rise in water level per hour and shall extend for a period of 72

hours. Records of leakages starting at different level of water in the reservoirs, if any, shall be kept.

- The reservoirs once filled shall be allowed to remain filled for a period of 7 days before any readings or drop in water level is recorded again at 7 days. The total drop in surface level over a period of 7 days shall be taken as indication of the water tightness of the reservoir, which for all practical purposes shall not exceed 40mm. There shall be no indication of leakages around the puddle collars or on the wall and bottom of the reservoir.
- If the structure does not satisfy the test requirements, and the daily drop in water level is decreasing, the period of test may be extended for further seven days and if the specified limit is not exceeded, the structure may be considered as satisfactory.
- In case the drop in water level exceeds the permissible limit with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer in charge to reduce the leakage in the permissible limit. The entire rectification work that shall be carried out in this connection shall be at Contractor's cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the water retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure will be condemned and the Contractor will dismantle and reconstruct the structure, to the original specification, at his own cost.

6.1.14. **Materials & Standards**

The term "materials" shall mean all materials, goods and articles of every kind whetherraw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer-in-charge, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificates and forward it to the Engineer-in-charge.

The specifications, standards and codes listed below are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between two standards the provisions more stringent shall be followed. In case of discrepancy between the Bid Specification and the Standards referred to herein, the Bid Specification shall govern.

IS No	Title
CONSTRUCTION PLANNING AND STORAGE OF MATERIALS	
4082	Recommendation on stacking and storage of construction materials at site (first revision)
7969	Safety code for handling and storage of building materials
EARTHWORK	
3764: 1992	Excavation work - Code of safety (first revision)
4081	Safety code for blasting and related drilling operations
FOUNDATIONS	
269	33 grade ordinary Portland cement.
432 (Part 1)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement : Part 1 Mild steel and medium tensile steel bars (third revision)
456	Code of practice for plain and reinforced concrete (Reaffirmed 1991)
2974 (Part 1)	Code of practice for design and construction of machine foundations : Part 1 Foundations for reciprocating type machines
2974 (Part 2)	Code of practice for design and construction of machine foundations : Part 2 Foundations for impact type machines (hammer foundations)
2974 (Part 3)	Design and construction of machine foundations - Code of practice : Part 3 Foundations for rotary type machines (medium and high frequency)
2974 (Part 4)	Code of practice for design and construction of machine foundations : Part 4 Foundations for rotary type machines of low frequency
2974 (Part 5)	Code of practice for design and construction of machine foundations : Part 5 Foundation for impact machines other than

IS No	Title
	hammers (forging and stamping press, pig breakers, drop crusher and jolter)
6403	Code of practice for determination of bearing capacity of shallow foundations.
PLAIN AND REINFORCED CONCRETE	
269	33 grade ordinary Portland cement
383	Coarse and fine aggregates from natural resources for concrete
456	Code of practice for plain and reinforced concrete
516	Method of test for strength of concrete
875 (Part 1)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 1 Dead loads -Unit weights of building material and stored materials
875 (Part 2)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 2 Imposed loads
875 (Part 3)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 3 Wind loads
875 (Part 4)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 4 Snow loads
875 (Part 5)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 5 Special loads and load combinations
650	Standard sand for testing of cement
1199	Methods of sampling and analysis of concrete
1786	High strength deformed steel bars and wires for concrete reinforcement
2502	Code of practice for bending and fixing of bars for concrete reinforcement
2505	Concrete vibrators - Immersion type - General requirements
4926	Ready mixed concrete
8112	43 grade ordinary Portland cement
9012	Recommended practice for Concreting
9103	Admixtures for concrete
10262	Recommended guidelines for concrete mix design

IS No	Title
12269	53 Grade ordinary Portland Cement
STEEL CONSTRUCTION	
104	Ready mixed paint, brushing, zinc chrome, priming
123	Ready mixed paint, brushing, finishing, semi-gloss, for general purposes to Indian Standard Colours No.445, 446, 448, 449, 451, 473 and red oxide
800	Code of practice for general construction in steel
7205	Safety code for erection of structural steel work
FLOORS AND FLOOR COVERINGS	
1237	Cement concrete flooring tiles
1443	Code of practice for laying and finishing of cement concrete flooring iles
8042	White Portland cement
WHITE WASHING, COLOUR WASHING AND PAINTING OF MASONRY, CONCRETE AND PLASTER SURFACES (CALCAREOUS SURFACES)	
44	Iron oxide pigments for paints
109	Ready mixed paint, brushing, priming, plaster, to Indian Standard Colour No. 361 and 631 White and off white
133	Enamel, interior : (a) undercoating, (b) finishing
158	Ready mixed paint, brushing, bituminous, black lead-free, acid alkali and heat resisting
168	Ready mixed paint, air drying, for general purpose
427	Distemper, dry, colour as required
428	Distemper, oil emulsion, colour as required
2395 (Part 1)	Code of practice for painting concrete masonry and plaster surfaces : Part 1 Operation and workmanship
2395 (Part 2)	Code of practice for painting concrete masonry and plaster surfaces : Part 2 Schedule
5410	Cement paint
6278	Code of practice for whitewashing and colour washi
9862	Ready mixed paint, brushing, bituminous, black lead-free, acid alkali, water and chlorine resisting

6.1.15. **SAMPLES AND TESTS OF MATERIALS**

The Contractor shall submit samples of such materials as may be required by the Engineer-in-charge and shall carry out the specified tests directed by the Engineer-incharge at the Site, at the supplier's premises or at a laboratory approved by the Engineerin-charge.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer-in-charge.

Approval by the Engineer-in-charge as to the placing of orders for materials or as to samples or tests shall not prejudice to any of the Employer's powers under the Contract.

6.1.16. **STANDARDS**

Materials and workmanship shall comply with the relevant Indian Standards (with amendments upto date).

Where the relevant standard provides for the furnishing of a certificate to the Engineer-incharge, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificates and forward it to the Engineer-incharge.

The specifications, standards and codes listed in this chapter are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

6.2. **EARTHWORK FOR BUILDINGS/RESERVOIRS**

6.2.1. **GENERAL**

The Contractor shall furnish all tools, plant instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Department's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8 m in case of buildings and 30 m in case of roads and pipe lines works intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting

and maintaining of substantial barricades around excavated areas and warning lamps at night.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Engineer-in-charge. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top.

Topsoil shall be stock piled separately for later re-use.

6.2.2. **CLEARING**

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Engineer-in-charge. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter / materials before fill commences.

6.2.3. **EXCAVATION**

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the approved drawings or such other lines and grades as may be agreed with the Engineer-in-charge Rough excavation shall be carried out to a depth of 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with material as approved by the Engineer-in-charge. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the approved drawings or as agreed with the Engineer-incharge. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with material as approved by EIC upto the required elevation at no cost to the department.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Engineer-in-charge shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

6.2.4. **ROCK**

6.2.4.1. **STRIPPING LOOSE ROCK**

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Engineer-in-charge, to fall or otherwise endanger the workmen, equipment, the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe portion, which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Engineer-in-charge, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

6.2.5. **FILL,BACKFILLING AND SITE GRADING**

6.2.5.1. **GENERAL**

All fill material shall be subject to the Engineer-in-charge's approval. If any material is rejected by Engineer-in-charge, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Engineer-in-charge after the fill work is completed.

6.2.5.2. **MATERIAL**

To the extent available, selected surplus soil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed unless otherwise stated. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Engineer-in-charge. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Engineer-incharge. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

6.2.5.3. **FILLING IN PITS AND TRENCHES AROUND FOUNDATIONS OF STRUCTURES, WALLS, ETC.**

The spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated to the satisfaction of Engineer-in-charge. Earth shall be rammed with approved compaction mechanism. Usually no manual compaction shall be allowed unless the Engineer-in-Charge is satisfied that in some cases manual

compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Engineer-in-charge.

The filling shall be done after the concrete or masonry is fully set and done in such a manner as not to cause undue thrust on any part of the structure.

6.2.5.4. **PLINTH FILLING**

Plinth filling shall be carried out with approved material such as soil, sand or murum as in layers not exceeding 15 cm, watered and compacted with approved compaction mechanism. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of large areas be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer-in-charge. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this be upto a maximum of 300 mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Engineer-incharge obtained prior to commencing filling.

The process of filling in the plinth, watering and compaction shall be carried out by the contractor in such a way as not to endanger the foundation columns, plinth walls etc. already built up. Under no circumstances Black cotton soil shall be used for plinth in filling.

For mechanical compaction rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Engineer-incharge, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

At some locations/ areas, it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

6.2.5.5. **SAND FILLING IN PLINTH AND OTHER PLACES**

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer-in-charge has inspected and approved the fill.

6.2.6. GENERAL SITE GRADING

Site grading shall be carried out as indicated in the approved drawings. Excavation shall be carried out as specified in the Department's Requirements. Filling and compaction shall be carried out as specified elsewhere unless otherwise specifications indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 200 mm and levelled uniformly and compacted as indicated above before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip.

6.2.7. FILL DENSITY

Unless otherwise specified the compaction, where so called for, shall comply with minimum 90% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

6.2.8. TIMBER SHORING

The provisions of relevant ISS shall apply.

6.2.9. DEWATERING

The Contractor shall ensure at his cost that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/ rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/ trenches required for further work. The method of pumping shall be approved by Engineer-in-charge, but in any case, the

pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any test necessary at the site with the approval of the Engineer-in-charge to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Engineer-incharge. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a build up of water in the opinion of the Engineer-in-charge obstructs the progress of the work, leads to unsanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuos inflow of water and the quantum of water to be handled is considered in the opinion of Engineer-in-charge, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Engineer-incharge, details of his well point system including the stages, the spacing number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

If any foundation pits are filled due to accumulation of surface flow during the progress of work or during rainy season, or due to any other cause all pumping required for dewatering the pits & removing silt shall be done without extra cost.

6.2.10. **RAIN WATER DRAINAGE**

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Engineer-in-charge.

6.3. **CONCRETE**

6.3.1. **GENERAL**

The Engineer-in-Charge shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer-in-Charge's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his

responsibilities. All materials which do not conform to the Specifications shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer-in-Charge and after establishing their performance suitability based on previous data, experience or tests.

6.3.2. MATERIALS

6.3.2.1. CEMENT

Unless otherwise called for by the Engineer-in-charge, cement shall be ordinary Portland cement (Grade33, Grade 43, Grade 53) ISI Marked conforming to IS : 269, IS : 8112 or IS : 12269 or Super Sulphated cement ISI Marked conforming to IS 6909 or super resistant Portland cement ISI Marked conforming to IS 12330 or Pozzolana Portland Cement conforming to IS 1489(part 1)

Sulphate resistant cement conforming to IS 12330 shall be used for all cement concrete works below ground level if the soil resistivity is less.

Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer-In-Charge.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Engineer-In-Charge and until the results of such tests are found satisfactory, it shall not be used in any work.

6.3.2.2. AGGREGATES (GENERAL)

It shall comply with requirement of IS 383 and as specified in IS 456-2000. Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/slit/organic impurities/deleterious materials such as iron pyrites, cod, mica, slate, clay alkali, soft fragments, sea shells and conform to IS : 383. Aggregates such as slag, crushed over burnt bricks, bloated clay aggregates, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Engineer-in-Charge.

Aggregates containing reactive silica shall not be used.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than ¼ of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete when specifically permitted. The plums shall be distributed evenly and shall not be closer than 160 mm from the surface. For heavily reinforced concrete members as in the case of ribs of main beams the nominal maximum size of aggregate shall be restricted to 5 mm less than minimum clear distance between the main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller. Coarse and fine aggregates shall preferably batched separately, specially for design mix concrete.

The largest possible size, properly graded should be used in order to reduce water demand.

Graded aggregate shall confirm to requirements in Table 1, 2, 3 & 4. All in aggregate shall confirm to requirements in Table 5.

Table 1

Graded Aggregate

IS Sieve Percentage Passing for Normal size of Aggregate **Designation**				
Mm	40 mm	20 mm	16 mm	12.5 mm
80	100	-	-	-
40	95-100	100	-	-
20	30-70	95-100	100	100
16	90-100	12.5	90-100	
10	10-35	25-55	30-70	40-85
4.75	0-5	0-10	0-10	0-10
2.36	-	-	-	-

Table 2

Single Sized Aggregate (Ungraded)

IS Sieve	Percentage Passing for Normal size of Aggregate

Designatio n

Mm	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
80	100	-	-	-	-	-
63	85-100	100	-	-	-	-
40	0-30	85-100	100	-	-	-
20	0-5	0-20	85-100	100	-	-
16	-	-	-	85-100	100	-
12.5	-	-	-	-	85-100	100
10	0-5	0-5	0-20	0-30	0-45	85-100
4.75	-	-	0-5	0-5	0-10	0-20
2.36	-	-	-	-	-	0-5

Table 3

Making Single Sized to Graded Aggregate

Cement Concrete Mix	**Nominal size of Graded Aggregate Required**	Part of Single Size Aggregate to be Mixed to Get Graded Aggregate (by Volume)				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
1:6:12	63	9	-	3	-	-
	40	-	9	3	-	-
1:5:10	63	7.5	-	2.5	-	-
	40	-	7.5	2.5	-	-
1:4:8	63	6	-	2	-	-
	40	-	6	2	-	-
1:3:6	63	4.5	-	1.5 1.5	-	-
	40	-	4.5	4.5	-	-
	20	-	-		-	1.5
1:2:4	40	-	2.5	1	-	0.5
	20	-	-	3	-	1
	12.5	-	-	-	3	1
1:1.5:3	20	-	-	2	-	1

Note : *Proportions indicated are by volume. If single sized aggregate specified is not*

Cement Concrete Mix	**Nominal size of Graded Aggregate Required**	Part of Single Size Aggregate to be Mixed to Get Graded Aggregate (by Volume)				
		50 mm	40 mm	20 mm	12.5 mm	10 mm

available*, the volume of single sized aggregates shall be varied with a view to obtain the graded aggregate.*

Table 4

Grading of Fine Aggregates

IS SIEVE Designation	**PERCENTAGE PASSING FOR**			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

Note : For crushed stone sands***, the possible limit on 150 micron IS sieve is increased to 20 percent. This does not affect 5 percent allowance permitted to other sieves.***

Table 5

All-in-Aggregate Grading

IS Sieve Designation	**Percentage Passing All-in-Aggregate Grading of**	
Mm	40 mm Nominal Size	16 mm Nominal Size
80	100	-
40	95-100	95-100
20	45-75	95-100
4.75 mm	25-45	30-50
600 micron	8-30	10-35
150 micron	0-6	0-6

Fine aggregates are divided into 4 zones. Typical good sand falls in Zone II grading, however, finer or coarse sand may be used with suitable adjustment in the ratio of quantities of coarse to fine aggregates.

Very fine sands as included in Zone IV grading should not be used except when the concrete is closely controlled by design mixes.

6.3.2.3. **WATER**

Water used for both mixing and curing shall conform to IS : 456-2000 and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials that may be deleterious to concrete or steel. The pH value of water shall not be less than 6.

6.3.3. **REINFORCEMENT**

Reinforcement shall be any of the following :

High strength deformed bars and wires to IS 1786.

Rolled steel Grade A made from structural steel to IS 2062.

All reinforcement shall be free from loose mill scales, loose rust and coats of paints, oil, mud or other coatings which may destroy or reduce bond.

6.3.4. **ADMIXTURES**

Accelerating, retarding, water reducing and air entraining admixtures shall conform to IS : 9103 and integral water proofing admixtures to IS : 2645.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer-in-Charge. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedments.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

6.3.5. **SAMPLES AND TESTS**

All materials used for the works shall be tested before use.

Manufacturer's test certificate shall be furnished for each batch of cement /steel and when directed by the Engineer samples shall also be got tested by the Contractor in a laboratory approved by the Engineer-in-Charge.

Sampling and testing shall be as per IS : 2386 under the supervision of the Engineer-inCharge.

Water to be used shall be tested to comply with requirements of IS : 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

6.3.6. CONCRETE

6.3.6.1. GENERAL

Concrete grade shall be as designated on approved drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq. mm as per IS: 456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5, M10, and M15 shall be NOMINAL MIX CONCRETE. Grade M20 can be nominal or design mix as per the requirement whereas all other grades, above M20 necessarily be DESIGN MIX CONCRETE.

6.3.6.2. DESIGN MIX CONCRETE

The mix design shall produce concrete having reduced workability (consistency) and strength not less than approximate values given in table below. Workability shall be controlled by direct measurement of water content and checking it at frequent intervals by method prescribed in IS 1199.

a) Mix Design and Testing

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall be cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in watertight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result. Synthetic fiber additive as per circular :SECY/RWSSMB/Circular /2014-15/1089-1113 Dated :- 09.06.2015 should be used for design mix.

The minimum cement content for Design Mix Concrete shall be as per IS: 456.

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish mix design to the Engineer-in-Charge well in advance of the concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS : 516 shall comply with the requirements of IS : 456.

Grade of Concrete	**Minimum Compressive Strength N/sq.mm at 7 days**	**Specified Characteristic Compressive Strength N/sq. mm at 28 days**
M15	10.0	15.0
M20	13.5	20.0
M25	17.0	25.0
M30	20.0	30.0
M35	23.5	35.0
M40	27.0	40.0

Grades lower than M20 shall not be used for reinforced concrete (general). Grading lower than M25 shall not be used for reinforced concrete in liquid retaining structures.

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Engineer-in-Charge is given below:

Structure / Member	**Slump in millimeters**	
	Maximum	**Minimum**
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	100	25
Slabs, Beams and reinforced walls	75	25
Pump & miscellaneous Equipment Foundations	100	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25

b) Batching & Mixing of Concrete

Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water-cement ratio specified for use by the Engineer-in-Charge shall be maintained. Each time the work stops, the mixer shall be cleaned out and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer-in-Charge. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS : 516 and IS : 456.

6.3.6.3. NOMINAL MIX CONCRETE

a) Mix Design & Testing

Mix Designing and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS : 456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 9 of IS : 456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

b) Batching & Mixing of Concrete

The Proportions of materials used for concrete of grades shall be as given below :

Proportions for Nominal Mix of Concrete

Grade of **Concrete**	**Total Quantity for Dry Aggregate** by **Mass per 50 kg of Cement (as Sum of Fine and Coarse Aggregates), in kg, Max**	**Proportion of Fine** Aggregate **to Coarse Aggregate (by Mass)**	**Quantity of Water** per **50 kg of Cement, in Max Litres**
M 5	800	Generally 1:2 Subject to an upper limit of 1:1.5 and a lower limit of 1:2.5	60
M 7.5	625	-do-	45
M 10	480	-do-	34
M 15	350	-do-	32
M 20	250	-do-	30

NOTES

The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and maximum size of coarse aggregate becomes larger. Graded coarse aggregate (see Table 5.1) shall be used.

Example: For an average grading of fine aggregate (that is, Zone II of IS 383 :1970, Table 4) the proportions shall be 1:1.5, 1:2 and 1:2.5 for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

This table envisages batching by weight,. Volume batching when done the nominal mixes would roughly be 1:3:6, 1:2:4 and 1:1.5:3 for M 10, M 15 and M 20 respectively.

For underwater concreting the quantity of coarse aggregate, either by volume or mass, shall not be less than 1.5 times nor more than twice that of the fine aggregate.

c) Mixing

Concrete shall be mixed in a mechanical mixer conforming to IS 1791. The mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. If there is segregation after unloading, the concrete should be remixed.

6.3.7. FORMWORK

Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

The design and engineering of the formwork as well as its construction shall the responsibility of the Contractor. However, if so desired by the Engineer-in-Charge, the drawings and calculations for the design of the formwork shall be submitted to the Engineer-in-Charge for the approval.

Formwork shall be designed to fulfill the following requirements:

(i) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

(ii) Made of suitable materials.

(iii) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

(iv) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

(v) Capable of easy striking out without shock, disturbance or damage to the concrete.

(vi) Soffit forms capable of imparting a camber if required

(vii) Soffit forms and supports capable of being left in position if required

(viii) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate and the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer-in-Charge. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer-in-Charge. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in-situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of the Engineer-in-Charge, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the Engineer-in-Charge, than that required as per drawing to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column

is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0 m or as approved by the Engineer-in-Charge. The Contractor shall temporarily and securely fix items to be cast (embedments/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

6.3.8. PREPARATION PRIOR TO CONCRETE PLACEMENT

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements- formwork, equipment and proposed procedure, shall be approved by the Engineer-in-Charge. Contractor shall maintain separate Pour Card for each pour as per the approved format.

6.3.9. CHECK FOR REINFORCEMENT AND CONCRETING

All reinforcement shall be checked and recorded prior to pouring of concrete by an authorised representative of the engineer in Charge. Similarly the entire concrete pouring work shall be done in the presence of authorised representative. The contractor shall therefore give a notice of a minimum three days to the engineer in Charge or his representative such that the works can be checked by him or his authorised representative.

6.3.10. TRANSPORTING,PLACING AND COMPACTING CONCRETE

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water. During hot or cold weather, concrete shall be transported in deep containers or by other suitable measures to reduce loss of water by evaporation and heat loss in cold weather may also be adopted.

In all cases concrete shall be deposited as nearly as practicable directly in its final position to avoid rehandling. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0 m. Care shall be taken to avoid displacement of reinforcement or formwork.

Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

(i) Continuously between construction joints and pre-determined abutments.

(ii) Without disturbance to forms or reinforcement

(iii) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.

(iv) Without dropping in a manner that could cause segregation or shock.

(v) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.

(vi) Do not place if the workability is such that full compaction cannot be achieved

(vii) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary in supported excavations, withdraw the linings progressively as concrete is placed.

(viii) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

(ix) Ensure that there is no damage or displacement to sheet membranes.

(x) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration shall be avoided; under vibration is likewise harmful.

The vibrator should penetrate rapidly to the bottom of the layer and atleast 15 cm into the preceding layer if there is any. It should be held generally 5 to 15 sec. until the compaction is considered adequate and then withdrawn slowly at thereof about 8 cm/s.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer-in-Charge. The slump shall

be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer-in-Charge. Concrete shall be protected against damage until final acceptance.

6.3.11. MASS CONCRETE WORKS

Sequence of pouring for mass concrete works shall be as approved by the Engineer-inCharge. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

6.3.12. CURING

- Curing and protection shall start immediately after the compaction of the concrete to protect it from
    - Premature drying out, particularly by solar radiation and wind;
    - leaching out by rain and flowing water;
    - rapid cooling during the first few days after placing;
    - high internal thermal gradient;
    - low temperature of frost;
    - vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement
- After the concrete has begun to harden i.e. 1 to 2 hr. after laying curingshall be started.
- All concrete, unless approved otherwise by the Engineer-in-Charge, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessain or other absorbent material for the period of complete hydration with a minimum of 10 days. The quality of curing water shall be the same as that used for mixing.
- Where a curing membrane is approved to be used by the Engineer-inCharge, the same shall of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Engineer-

in-Charge before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

- When concrete is used as subgrade for flooring, the flooring may be commenced before the curing period of subgrade is over, but curing of subgrade shall be continued along with the top layer of flooring for a minimum period of 10 days.
- Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

6.3.13. CONSTRUCTION JOINTS AND KEYS

The position and arrangement of construction joints shall be as indicated by the contractor in his working drawings dually approved by the department. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer-in-Charge.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Engineer-in-Charge.

Before resuming concreting on a surface which has hardened all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and horizontal layers.

When concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the concrete mix. This cement slurry or mortar shall be freshly mixed and applied immediately before placing concrete.

6.3.14. FOUNDATION BEDDING

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer-in-Charge. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

Excavation, in clay or other soils that are likely to be affected by exposure to atmosphere, shall be concreted as soon as they are dry. Alternatively, unless otherwise mentioned the bottom of the excavation shall be protected immediately by 8 cm thick layer of cement concrete not leaner than M10 or in order to obtain a dry hard bottom, the last stretch of excavation of about 10 cm shall be removed just before concreting.

6.3.15. REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

Immediately after the shuttering is removed, all defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc, shall be inspected by the Engineer-inCharge who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Engineer-in-Charge.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer-in-Charge as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineerin-Charge.

6.3.16. HOT WEATHER REQUIREMENTS

Concreting during hot weather shall be carried out as per IS 7861 (Part I).

Adequate provision shall be made to lower concrete temperatures which shall not exceed 40 deg C at time of placement of fresh concrete.

Where directed by the Engineer-in-Charge, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

6.3.17. COLD WEATHER REQUIREMENTS

Concreting during cold weather shall be carried out as per IS: 7861(Part II).

The ambient temperature during placement and upto final set shall not fall below 5 deg. C. Approved antifreeze/accelerating additives shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

6.3.18. LIQUID RETAINING STRUCTURES

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The Contractor shall make all arrangements for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the engineer-in-charge. All such rectification shall be done by the contractor to the entire satisfaction of the engineer-in-charge at no extra cost to the department.

6.3.19. WATERSTOPS

6.3.19.1. MATERIAL

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS : 12200. Testing shall be in accordance with IS : 8543.

a)	Tensile strength	:	3.6 N/mm^2 minimum
b)	Ultimate elongation	:	300% minimum
c)	Tear resistance	:	4.9 N/mm^2 minimum
d)	Stiffness in flexure	:	2.46 N/mm^2 minimum
e)	Accelerated extraction i) Tensile	:	10.50 N/mm^2
	strength ii) Ultimate	:	minimum
	elongation		250% minimum
f)	Effect of Alkali	:	7 days
	i) Weight increase	:	0.10% maximum
	ii) Weight	:	0.10% maximum
	decrease iii)	:	± 5 points
	Hardness change		

g)	Effect of Alkali	:	28 days
	i) Weight increase	:	0.40% maximum
	ii) Weight decrease	:	0.30% maximum
	iii) Dimension change	:	± 1%

PVC waterstops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

PVC waterstops shall be ISI Marked of approved manufacture. Samples and the test certificate shall be got approved by the Engineer-in-Charge before procurement for incorporation in the works.

6.3.19.2. **WORKMANSHIP**

Waterstops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion-welded type as per manufacturer's instructions.

Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/ end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting waterstops shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

6.3.20. **PREFORMED FILLERS AND JOINT SEALING COMPOUND**

6.3.20.1. **MATERIALS**

Preformed filler for expansion / isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS : 1838 Part I or IS 1838 Part 2.

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS:702. Bitumen primer shall conform to IS : 3384.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS:1834.

Other organic solvents such as polysulphate based joint sealents to IS:1433 Part 1 or IS 12118 Part 1 may be used with the approval of Engineer-In-Charge.

6.4. STRUCTURAL STEEL WORK

6.4.1. FABRICATION

6.4.1.1. GENERAL

As much fabrication work as is reasonably practicable work shall be completed in shops, where steel work is fabricated.

All workmanship and finish shall be of the best quality and shall conform to the bestapproved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Tolerances for fabrication of steel structures conform IS 7215. Tolerances for erection of steel structures shall conform to IS 12843.

6.4.1.2. MINIMUM THICKNESS OF METAL -CORROSION PROTECTION

Unless, otherwise specified, the thickness of steel section shall be governed as below:

Steel work exposed to weather

Where steel work is directly exposed to weather and is fully accessible for clearing and repairing the thickness shall not be less than 6 mm; and where steel is exposed to weather and is not accessible for cleaning and painting, the thickness shall not be less than 8 mm. This shall not apply for hot rolled sections covered by Indian Standards.

Steel work not directly exposed to weather

The thickness of steel work not directly exposed to the weather shall be not less than 6 mm. The thickness of steel in secondary members shall be not less than 4.5 mm. For hot rolled sections to Indian Standards, the mean thickness of flange be considered and not the web thickness.

The requirements (a) and (b) above does not apply to light structural work or sealed box section or to steel work in which special provision against corrosion has been made and also in case of steel work exposed to highly corrosive fumes or vapour in which case the thickness shall be as approved by the Engineer-In-Charge.

6.4.1.3. DRAWINGS PREPARED BY THE CONTRACTOR

The contractor shall prepare all fabrication working and erection drawings for the entire work. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

All fabrication drawings shall be submitted to the Engineer-In-Charge for approval.

No fabrication drawings will be accepted for Engineer-In-Charge's approval unless checked and approved by the contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the contractor only after Engineer-In-Charge's approval of fabrication drawings. Approval by the Engineer-In-Charge of any of the drawing shall not relieve the contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon.

The drawings prepared by the contractor and all subsequent revisions etc. shall be at the cost of the contractor for which no separate payment will be made.

6.4.1.4. **WELDING**

Welding shall be in accordance with IS 816, IS 819, IS 1024, IS 1261, IS 1323 and IS 9595 as appropriate.

Welding procedure shall be submitted to the Engineer-in-Charge for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS :7310 (Part 1) and IS :7318 (Part 1).

For welding any particular type of joints, welders shall give evidence acceptable to Engineer-In-Charge of having satisfactorily completed appropriate tests as per IS 817 Part 1, IS 1393, IS 7307, IS 7310 Part 1 and IS 7318 Part 1 as appropriate.

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Engineer-in-Charge shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during period of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately penned with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below -5 Deg. C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

All welds shall be inspected for flaws

The correction of defective welds shall be carried out in a manner approved by the Engineer-in-Charge without damaging the parent metal.

6.4.2. PAINTING

All fabricated steel material, except those galvanised shall receive protective paint coating as prescribed in IS 1477 Parts 1 & 2.

All surfaces to be painted, oiled or otherwise treated shall be dry thoroughly cleaned to remove all loose scale and loose rust.

Shop contact surfaces need not be painted unless otherwise specified.

Surfaces not in contact but inaccessible after shop assembly shall receive full specified protective treatment before assembly. This does not apply to interior of hollow seatings.

Chequered plates shall be painted after the details of painting are approved by the Engineer-In-Charge.

In case of surfaces to be welded, steel shall not be painted within a suitable distance of any edges to be welded if paint would be harmful to the welder or impair the quality of welds.

Welds and adjacent parent metal shall not be painted prior to slugging, inspection and approved.

Parts to be encased in concrete shall not be painted or oiled.

6.4.2.1. SURFACE TREATMENT

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The type of surface treatment shall be as specified in the respective item of work. The workmanship shall generally conform to the requirements of IS 1477- Part I.

6.4.2.2. PAINTING OF FERROUS SURFACE

Unless and otherwise mentioned, all MS fabricated items used in the project shall be painted with any of the three options given for interior or external works. The specifications adopted for every component must be got approved from the Engineer-in-Charge, before use.

Sr. No.	Final Finish Require d	Primer	Undercoat	Finishing Coat	Number and Thickness of Coating
(1)	(2)	(3)	(4)	(5)	(6)
A. FOR INTERIORS					
(i)	Full glos s (enamel gloss)	IS 102: 1962 (see Note) IS 207:1964	IS 133:1993 (B)1) IS 2933:1975 (B, S)1)	IS 133:1993 (B)1) IS 2933:1975 (B, S)1)	For optimum results, two coats of primer, one undercoat, and two finishing coats are recommended. The total film thickness shall be not less than 100 microns.
Sr. No.	Final Finish Required	Primer	Undercoat	Finishing Coat	Number and Thickness of Coating
(1)	(2)	(3)	(4)	(5)	(6)
(ii)	Oil gloss	Same as for (i)	IS 133:1993 (B) OR IS 144:1950 (S)		Same as for (i)
(iii)	Metallic finishes	Same as for (i)	-	IS 2339:1963 (B) IS 2339:1963 (S) OR Bituminous aluminium paints	One coat of primer and two finishing coats; if bituminous aluminium paint is used, three coats will be necessary.
(iv)	Bitumen	Same as for (i)	-	IS 158:1981	Three coats of bitumen shall be used.
B.FOREXTERIORS					
(v)	Full gloss	IS 102: 1962 (see Note)	IS 2933:19751)	IS 2933:19751)	For optimum results, two coats of primer, one undercoat, and two finishing coats are recommended. The total film thickness shall be not less than 100 micron.
(vi)	Oil gloss	Same as for (v)	-	IS 117:1964 OR IS 128:1962	Same as for (vii)
(vii)	Metallic finishes	Same as for (v)	-	IS 2339:1963 OR Bituminous aluminium paint	One coat of primer and two finishing coats; if bituminous aluminium paint is used, three coats will be necessary.

NOTE – Paint primer conforming to IS 102:1962 may be used only where special precautions for drying of the primer coat taken and where satisfactory drying conditions is ensured before application of further coats.1)

Each of these Indian Standards cover both undercoating and finishing paints, and paints appropriate for the function shall be used.

6.4.2.3. MATERIALS

1) All the materials shall be of the best quality from an approved manufacturer. contractor shall obtain prior approval of the engineer-in-charge for the brandof manufacturer and the colour/shade prior to procurement for usage in the works.

2) Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.

3) The colour and shade shall conform to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade/number from the alternatives available, contractor shall adopt trial painting in small patches in consultation with and as directed by the engineer-in-charge.

4) All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically directed by the engineer-in-charge.

5) Paints shall be stirred thoroughly to keep the pigment in suspension.

6) Contractor shall at his own cost arrange for testing of paints as per relevant Indian Standard laboratory whenever engineer-in-charge wants the tests to be carried out for each batch of paints. Test results shall be submitted to the engineer-in-charge for obtaining approval.

6.4.2.4. WORKMANSHIP

1) The type and the number of coats of the primer paint and finish paint shall be as specified in the respective items of work.

2) Painting shall be carried out only on thoroughly dry surfaces.

3) No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 50^{0} C or lower.

4) Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

5) The application of paint film serve the twin purpose of protecting the steel from corrosion and giving the decorative appearance. A paint which gives the steel adequate protection over a long period together with good appearance shall therefore be adopted.

6) Workmanship shall generally conform to requirements specified in IS 1477-Part-II.

7) It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film without "holidays". After the first coat becomes hard dry a second coat of primer shall be applied by brushing to obtain a film free from holidays.

8) Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces

   of the first coat during transport from shop to site and during erection shall be provided with a touch up coat of the primer.

9) The dry film thickness of each coat of primer shall be not less than 25 microns.

10) Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection to the steel surface over a long duration.

11) Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Filler prepared by whiting and linseed oil by craftsmen at site shall never be used as such fillers may be unbalanced and incompatible with primer and finishing coats. Application of filler shall be done with good putty knife and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, due as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.

12) Painting shall be carried out either by brushing or by spraying. contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

13) After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

14) The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.

15) At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the engineer-in-charge.

16) Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.

17) Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.

18) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

19) Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

20) Portion of steel members embedded to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50 mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall receive the painting as specified.

21) Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. The breakdown of a paint film is progressive from the top finish paint to the primer coat and the object of maintenance painting is to renovate periodically to effectively check the breakdown and protect the steel surfaces from corrosion. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause 7 of IS 1477 - Part II.

22) Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls etc.

6.5. **BRICKWORK**

6.5.1. **MATERIALS**

Bricks used in the works shall conform to the requirements laid down in IS : 1077, IS 2180, IS 2222, IS 2691, IS 3952, IS 6165. The class of the bricks shall be as specifically indicated in the respective items of work prepared by the Contractor.

Bricks shall have following dimensions :

	Length Mm	**Width mm**	**Height mm**

Non Modular Bricks	230	110	70
	230	110	30

Common burnt clay bricks are classified on the basis of compressive strength as given below:

Class designation	10	7.5	5	3.5
Avg. compressive strength N/ mm^2	10	7.5	5	3.5

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/ machine moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be uniform in colour, tolerance of brick dimension shall be 3% for designation 10 & above and 8% for lower designation. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck.

6.5.2. **THE SAMPLE SIZE FOR ALL THE TESTS SHALL BE AS FOLLOWS :**

Brick	Lot size	Sample Size
Class 10	more than 50000 bricks	20 bricks
7.5, 5, 3.5	more than 100000 bricks	20 bricks

The sampling shall be at random & samples shall be stored in a dry place until tests are done.

6.5.3. **COMPRESSIVE STRENGTH :**

Five bricks shall be tested. The average compressive strength shall be as per class designation. The compressive strength of individual brick shall not be less than 20 % of the specified value.

6.5.4. **WATER ABSORPTION :**

Five bricks shall be tested for water absorption and shall not exceed 20 % by weight upto class 12.5 & 15% by weight for higher classes.

6.5.5. **EFFLORESCENCE :**

Five bricks shall be tested for efflorescence. The efflorescence shall be 'nil' to ' moderate'

Sample bricks shall be submitted to the Engineer-in-Charge for approval and bricks supplied shall conform to approved samples. If demanded by Engineer-in-Charge, brick samples shall be got tested as per IS : 3495 by Contractor. Bricks rejected by Engineer-inCharge shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand.

Mortar leaner than 1.5 and richer than 1:3 shall not be used.

6.5.6. PREPARATION OF MORTAR

6.5.6.1. **Materials**

1) Water :

   Water used shall be clean and reasonably free from injurious or deleterious materials such as oils, acids, alkalis, salts. The pH value of water shall not be less than 6.

2) Cement :

   Cement shall conform to any of the following :

   33 Grade Ordinary Portland Cement IS : 2697
   43 Grade Ordinary Portland Cement IS : 8112 53 Grade Ordinary Portland Cement IS : 12269

3) Sand :

   Sand for masonry mortars shall confirm to IS 2116

6.5.6.2. PREPARATION OF MORTARS :

Mortars shall be prepared and tested as per IS 2250. Mixing of cement mortar shall be done in a mechanical mixers.

6.5.6.3. WORKMANSHIP

Workmanship of brick work shall conform to IS : 2212. All bricks shall be thoroughly soaked in clear water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work prepared by the Contractor. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/ 115 mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of

one brick thick or half brick thick wall, atleast on e face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than on e brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one meter. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10 mm/ 15 mm by raking tools during the progress of work when the mortar is still green, so as to provided a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During harsh weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Engineer-in-Charge.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS : 2750 and IS : 3696 (Part - I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer-in-Charge. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/ pointing.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/ floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS : 1397 or 2 layer of 50 micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 150 mm thickness, projecting 150mm on either sides of the beam, duly finished on top with 2 layer of Kraft paper Grade 1 as per IS : 1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to predeflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transomes and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.

Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

6.6. UNCOURSED RANDOM RUBBLE MASONRY, IN FOUNDATION PLINTH AND SUPERSTRUCTURE

6.6.1. MATERIALS

Stones for the works shall be of the specified variety which are hard, durable, fine grained and uniform in colour (for superstructure work) free from defects like cracks, sand holes, patterns of soft / loose materials veins, other defects. Quality and work shall conform to the requirements specified in IS : 1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer-in-Charge for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-stand mortar for stone masonry works shall be as per IS 2250.

6.6.2. SCAFFOLDING

Type of scaffolding to be used shall be as specified in the section of brick masonry.

6.6.3. **WORKMANSHIP**

For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dress stones for the facing.

For all R.R. masonry in superstructure the masonry shall be well bounded, faced with hammer dressed stones with squared quoins at corners. The bushing on the face shall not be more that 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depression more than 10mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the herating shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in wall upto 600 mm thick and in case of wall above 600mm thickness, a set of two or more bond stones overlapping each other by at least 150mm shall be provided in a line from face to back. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45 deg. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

6.7. DAMP - PROOF COURSE

6.7.1. MATERIALS AND WORKMANSHIP

All the walls in a building shall be provided with damp-proof course covering plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other opening. Damp-proof course shall consist of minimum 50mm thick cement concrete of 1:2:4 nominal mix with nominal reinforcement and approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10mm down graded coarse aggregates.

The surface of brick work/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster. Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

6.7.2. MISCELLANEOUS INSERTS,BOLTS ETC.

All the miscellaneous inserts such as bolts, pipes, plate embedments etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction Drawing to be prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the Engineer-in-Charge. In the event, of any of the inserts are improperly installed, contractor shall make necessary arrangement to remove and reinstall at the correct locations/levels all as directed by the Engineer-inCharge.

6.8. BASE CONCRETE

The thickness and grade of concrete and reinforcement shall be as specified in items of works prepared by the Contractor.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

6.9. CEMENT PLASTERING WORK

6.9.1. MATERIALS

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer-in-Charge. If so desired by the Engineer-in-Charge sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required restoring consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

6.9.2. **WORKMANSHIP**

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/ window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10 mm / 20mm for brick/ stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface. a) Interior plain faced plaster

This plaster shall be laid in a single coat of 12 mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer-in-Charge.

Plain Faced Ceiling plaster

This shall be applied in a single coat of 6 mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster

This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14 mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20 mm thick if specified for uneven faces of brick walls or for random/ coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

For external plaster, the plastering operation shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/ windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 6.6.1.8.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2 m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/ thermal movement.

Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

6.10. CEMENT POINTING

6.10.1. MATERIALS

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS : 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles.

Sand shall be approved by Engineer-in-Charge and if so directed it shall be washed/ screened to meet specification requirements.

6.10.2. **WORKMANSHIP**

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15 mm/ 20 mm deep in brick/ stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/ dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joint shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Wherever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer-in-Charge.

6.11. **SYNTHETIC FIBER ADDITIVES**

(AS PER CIRCULAR :SECY/RWSSMB/Circular /2014-15/1089-1113 Dated :- 09.06.2015)

Synthetic fibers, made of 100% virgin grade polypropylene, should be added to concrete for special application to enhance properties (clause 5.8 of IS 456 as per amendment 3 August 2007). The fiber should be as per guideline of ASTM C 1116 (type III) or equivalent . Synthetic fiber should be used in all components of water retaining structures as per direction of Engineering In charge in cement plaster/ cement concrete flooring/ Plain or RCC work. Synthetic fiber may be used 6mm(in plaster)/12mm size (in concrete)@ rate of 125 Gms per 50 kg of cement or in the ratio as specified by manufacturer specification and direction of Engineer In Charge.

6.12. **SPECIFICATIONS OF SYNTHETIC FIBER ADMIXTURE FOR RCC**

WORKS

(AS PER CIRCULAR :SECY/RWSSMB/Circular /2014-15/1089-1113 Dated :- 09.06.2015)

1. PROPERTIES:-

The synthetic fiber should be as per guideline of ASTM C 1116 (type III)

The Synthetic Polyolefin (Polypropylene and Polyethylene) Fiber used for RCC of water retaining structure should be having followings properties-

1. Compliance……A.S.T.M. C-1116
2. Length of fiber :- Minimum 6mm(in plaster)/12mm (in concrete)
3. Construction :- Straight + Fibrillated Mesh Fiber
4. Melting Point :- 165 Degree Celsius
5. Absorption :- Nil
6. Acid Resistance :- Excellent
7. Alkali Resistance :- Excellent
8. Salt Resistance :- High
9. Thermal Conductivity :- Low
10. Tenacity :- 6.5 GPD + Elongation : 19% maximums
11. Specific Gravity :- 0.92g/cc
12. Elastic Modulus :- 500-700 ksi

2. Dosage :-

For reinforced cement concrete minimum dosage of fiber admixture shall be as 0.900 Kg per cum of cement concrete or @ 125 g/50 kg bag of cement whichever is more.

3. Mixing Process :-

The Synthetic fiber is a physical micro-reinforcement hence no additional water shall be required for this. The admixture shall be directly mixed in rotating mixture under supervisionof Engineer In Charge.

6.13. WATER-PROOFING ADMIXTURES

Water-proofing admixtures shall be ISI Marked conforming to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer-in-Charge.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 7. Specifications for Pumping Station (Mechanical & Civil)

7.1. General

The technical specifications for the Mechanical and Electro-Mechanical material and equipment(s) are detailed below.

All valves, MS pipes and specials used in the pumping stations shall conform to the specifications laid down in Chapter for specifications of pipes and valves in this Volume II of tender document.. The design criteria, material specifications, workmanship and testing of materials used for all civil works shall confirm to provisions laid down in Chapter of specifications of civil works. Pre dispatch inspection, pre commissioning tests, commissioning and trial runs shall be as detailed in respective Chapters.

7.2. Standards

Except as otherwise specified in these technical specification, the Indian Standards and Codes of Practice shall be adhered to for the design, manufacturing, inspection and factory testing, handling, installation and site testing of all material and equipment used for the work, or where a IS standard does not exist, to an approved national or international standard.

Only equipment supplied by reputed manufacturers and approved by the Engineer in Charge will be accepted.

7.3. Mechanical Plant & Equipment

7.3.1. General

It is not the intent to specify herein all the details pertaining to the design, drawing, selection of equipment/materials, procurement, manufacture, installation, testing & commissioning, however, the same shall be of high engineering standard and shall comply with all currently applicable standards, regulations & safety codes.

7.4. Pumps

7.4.1. System Head Curves

The bidder shall submit system head curves after detailed survey and layout planning of the entire system for the approval of the Engineer-in-Charge. The selected pumps shall be suitable for operation in different combination/speed with the range defined by the upper and lower system head curves.

7.4.2. General Features of Pumps

A. TYPE OF PUMPS,

Centrifugal submersible pumps or conventional Vertical Turbine pumps of with suitable drive. Pump drive shall be of 0.44 kV rating.

B. NPSH

The NPSH provided for the pumps shall be at least 0.5 m more than that required for the pump under all conditions of operation.

Design, manufacture and performance of all pumps specified in scope of work of vol.II shall comply with the requirements of the latest edition (as on date of submission of bids) of the applicable, Codes and Standards:

No.	Standard	Title
1	IS:6595	Horizontal centrifugal pumps for clear, cold and fresh water.
2	IS:9079	Technical requirements for mono-block pumps
3	IS:5120	Technical requirements for Roto-dynamic, special purpose pumps.
4	IS:9137	Code for Acceptance Tests for Centrifugal, Mixed flow and Axial pumps.
5	IS:13536 ISO:5199	Technical specification for centrifugal pumps – Class 2

7.4.3. Pump Duty Points

Based on the detailed survey and the water demand, the duty points required for the pumps is specified herein after. However, due to minor change in alignment, the levels of inlet and outlet at the terminal points etc. minor changes are expected which shall only be finalized after detailed layout plan of head works and the L-section of the mains

is finalized. Thus the final selected pumps may therefore require suitable changes for operation in different combination/speed which the Contractor has to make in his final designs submitted for approval on the basis of final L-section of mains and levels of reservoirs.

As it is the responsibility of the contractor to provide the designed flow to all the GLSRs, CWRs, DMAs thus the contractor on his own cost has to do the required surveys to verify the department data and the designs. However to fulfill the contractors obligation the duty conditions asked herein after can be changed to suit the system requirement as per the prevailing site conditions.

Detail of proposed duty conditions of pumps sets to be installed under the contract is given in Chapter-2 of Vol-II of tender document.

7.4.4. **Design requirements**

1. The Pump shall be capable of developing the required total head at rated capacity for correction. The pumps shall operate satisfactorily at the point on Q-H Characteristic curve over a range of (-) 30% to (+) 10% capacity.
2. The total Head curve shall be continuously rising towards the shut off. The shut off head shall be at least 115% of the total head. The pump should deliver at least 125% of its rated capacity at 75% of the specified total Head.
3. The required NPSH at duty point shall be at least 1.0 M less than the available NPSH.
4. Pumps shall run smooth without undue noise and vibration. The velocity of vibration shall be less than 4.5 mm/sec. Noise level shall be limited to 85 dBA at a distance of 1.86 m.
5. The efficiency of the pump as specified above shall be binding for all the bidders.
6. The bidder shall select suitable submersible or conventional vertical turbine pumps (for Raw/ Clear water pump house) For operation of raw/clear water pumping in the specified operating range. All the pumps for the particular pressure main shall be of similar characteristics.
7. The bidder may opt for combination of fixed speed pumps and operation of pump for varying pumping hours, installation of pumps in series to achieve the required flow within the flow range.
8. All pumps shall be provided with suitable motors and accessories.
9. All the pumps shall be capable of developing the required total head at rated capacity of design discharge for continuous operation. The Bidder shall match the performance curves of pumps to the operating range.
10. The bidder shall guarantee a minimum overall efficiency for pumps as per reference given in CPHEEO manual or offered by manufacturer, whichever is high, corresponding to delivery of design discharge at duty point. The bidder shall specify the pump performance
11. Pumps shall be installed with positive suction head.
12. The pump shall operate satisfactorily at any point between the maximum and minimum system resistance, or at the end of the pump performance curve with

respect to the NPSH/positive head available at the lowest permissible suction water level. The pump characteristics should be selected on the basis of existing layout of pumping station, suction manifold and clear water reservoirs to ensure that the requirements are met.

13. The pumps shall be capable of reverse rotation up to 125% rated full speed of the drive motor, due to back flow of water, without damage or loosening of threaded components.
14. The specifications for flanges shall be as mentioned in the Chapter of "Specifications of pipeline work".
15. Spare parts supplied with the pump shall be identical to respective pump components and shall be from original manufacturer.
16. Pumps shall run smooth without undue noise or vibration. Noise levels and velocity of vibrations shall be within acceptable limits. Noise level shall be limited to 85 dba at a distance of 2 m. Velocity of vibrations shall be within 4.5 mm/s as per relevant Hydraulic Institutes Standards and IS.
17. Unless otherwise specified the drive unit power rating shall be the maximum of the following requirements:
    a. 15 % margin over the pump shaft input power required for the flow and head as considered in para (5) above, for pumps of BHP more than 50 HP.
    b. % margin over the maximum shaft input power required within the "Range of Operation" as per the upper and lower system resistance curves for pumps of BHP more than 50 HP.
    c. 30 % margin over the maximum shaft input power required within the "Range of Operation" as per the upper and lower system resistance curves for pumps of BHP less than 15 HP.
18. The bidder shall confirm that the pumps shall not be of a new design and a pump of at least the same design and same size has been supplied and tested satisfactorily at least at two locations. The details of locations shall be submitted in schedules.

Description of work: Item supplied under the contract shall perform the intended function. Scope of work under the contract shall include all necessary materials, equipment and services as per list of goods and related services under clause 1. Pumps shall be placed in proper operating condition in full conformity with the specifications, engineering data, and instructions under technical specifications here under.

a) <u>Quality Assurance:</u>

The equipment manufacturer shall have in house engineering, programming, fabrication and testing capability to expedite the project in its entirety.

The supplier shall submit the Quality Assurance Plan for pumps to be supplied under the contract for approval of the procurement entity. The material shall be dispatched only after approval and in accordance to approved QAP meeting all the quality standards of the industry.

7.4.5. Specifications for Submersible/ Conventional Vertical Turbine Pumps

7.4.5.1. General

The design, manufacture and testing of pumps shall conform to IS 1710 - 1972 with latest amendments or any equivalent international standards. The performance of pumps shall be guaranteed as per IS : 5120. The pumps shall give total discharge against total head, as specified. Characteristic curves for pumps shall be furnished with calculation for power requirement. The KW arrived at end must not be overloading for the required discharge.
Pumps shall be with single delivery to a common discharge manifold.

a. While superimposing the Q-H pump performance, pump and station losses are to be deducted from it. Accordingly, the pump and station losses are to be added to the pump head at intersection of pump curve and system resistance to arrive at the duty head of the pump. The characteristic curve (Q-H pump performance) for the solo pump, two pump and three pump in operation shall be provided by the supplier.
b. The duty point is to be guaranteed.
c. The approve efficiency with in the approved operating range, at the time of supply, of the pumps installed under the contract shall be maintained throughout the contract period with a permissible reduction of **0.40 %** efficiency per year after 1 year of operation of pump for complete duration of O&M period.
d. The pump set foundations dimensions shall, if required, altered during installation by the bidder and shall also be checked that the pump foundations are suitable for 120% of dead load and 200% of dynamic load for pumps of proposed parameters at design head with existing motors.
e. Out of the total number of pumps supplied under this contract, at least one pump is to be tested for performance test at shop in presence of Procurement Entity's representative. All costs towards inspection shall be borne by the supplier.
f. Q vs. H curves super-imposed on system resistance curves
g. The Contractor will provide as built completion drawings and operation and maintenance manuals at the completion of the works.

7.4.5.2. Design Requirements

(i) The pumps shall be capable of developing required total head at the rated capacity. Shut off heads for pumps operating in parallel shall be the same.

(ii) Pumps shall be suitable for single as well as parallel efficient operation at any point in between the minimum and maximum system resistance. Bidders shall prepare system resistance curves & superimpose the pump performance curves, for single and parallel operations with the system resistance curves for minimum and maximum static head conditions and submit the same for review.

(iii) The total head capacity curve of the pumps shall be continuously rising towards shut off with the highest at shut off. The shut off head of the pump shall be minimum 140% of the duty point of the head. The pumps shall deliver minimum 125% of its rated capacity at 75% of the specified total head.

(iv) The speed of the pump shall not exceed 1000 rpm. The duty point of the pump shall be at the Best Efficiency point (BEP) or to the left of BEP.

(v) Pump motor power rating shall be the larger of the following:

(vi) a) 115% of the power required at duty point.

(vii) b) 110% of the power required at minimum system resistance condition.

(viii) Pump operation shall be smooth without undue noise and vibration. The velocity of vibration shall be within 4.5 mm/sec. The noise level shall be limited to 85 dB(A) at a distance of 1.86 m.

(ix) Pumps shall have continuously rising and stable head capacity characteristic. The pumps shall operate throughout the range of operation from maximum discharge to shut off condition satisfactorily without noise or undue vibration.

(x) Pumps shall be capable of reverse rotation up to runaway speed due to back flow of water without causing any damage. The Contractor shall indicate the time period for which the pumps can be allowed to rotate in the reverse direction. The motor shall be provided with a separate thrust bearing / antifriction taper roller bearing suitable for reverse rotation. The thrust bearing shall be capable of sustaining maximum thrust occurring in the motor. The antifriction type thrust bearing shall be designed for minimum 40,000 hours rated life. Temperature elements of 100ohms resistance shall be provided at the bearing for continuous sensing of bearing temperature.

(xi) The pumps shall run without any damage to it or its motor for 5 minutes at shut-off condition.

(xii) The impeller shall be dynamically balanced. The peak vibration of the pump set shall not exceed allowable limits (75 microns).

(xiii) The impeller adjustment shall be such that the impeller run free in any installed condition despite extension of line shaft caused by hydraulic down thrust, weight of shafting and weight of impeller.

(xiv) The Contractor shall indicate the minimum submergence required for the pumps and ensure that the submergence provided is adequate to meet the NPSH requirement of the pump. The pumps shall have flooded suction as indicated in the tender drawings.

The pumps shall be non-pull out type and the assembly shall be so constructed that the pump, motor and the piping can be taken out for maintenance within the space provided. The pump and the motor shall have rigid construction, free from vibration on operation of the pump.

7.4.5.3. **Construction**

a. General: Pumps shall be of vertical type complete with bowl and column assemblies, suction strainer, bell mouth, discharge elbow, motor stool, thrust bearing. Pump shall work satisfactorily even when screen gets clogged up to 50%. The bowl assembly shall consist of rotating impeller, which are housed in stationery

bowls having guide vanes. The bowl shall also include the housing of the bottom pump shaft bearing. The column assembly shall consist of the column pipe to convey the liquid handled from bowl assembly, shaft assemblies and shaft bearings, discharge elbow. The discharge shall be as per pump parameters.

b. In order to avoid wastage of water through continuous gland leakage, externally removable, shaft mounted, self-aligning, cartridge type **mechanical seal** of reputed make shall be provided.

c. Suction Strainer: Each pump shall be provided with suction strainer to prevent entry of floating materials and debris, which may damage the pump. The strainer shall be fabricated from stainless steel conforming to SS 304 . The net opening area of the strainer shall be minimum 3 times the opening of the bell mouth. It shall be designed such that, it will cause minimum choking or clogging.

d. Bowl: The pump bowl shall be robust in construction, free from any casting defects. The surface shall be smooth. The bowl shall be equipped with replaceable wearing rings. Liquid passage shall be smooth finished and the bowl shall contain bushes to serve as bearings for the impeller shaft. The inside of bowl shall be painted with anti-corrosive paint and the outside shall be epoxy painted.

e. Impeller: Impellers for the pumps shall be with machined internal and external surfaces. Arrangement shall be provided to prevent loosening during operation including rotation in reverse direction. The impeller shall be balanced dynamically. The impeller shall be properly machined, with liquid passage hand finished with seal rings on their hubs. They shall be adjustable vertically by means of an adjusting nut in the head assembly. Impeller shall be securely fastened to the impeller shaft with keys, taper bushings or locknuts. To avoid internal resonance the number of vanes on diffuser shall not be equal to or be a multiple of number of vanes on impeller. The impeller shall be of enclosed type; positively locked and keyed to pump shaft. Means shall be provided to prevent loosening during operation including rotation in reverse direction.

f. The pump shall be provided with removable and renewable labyrinth profile casing ring. Materials and hardness of the impeller and casing wear rings shall be selected to ensure that they are not susceptible to galling and premature wear.

g. Pumps shall be designed for Low maintenance cost by way of access to the parts to be serviced (removal/fitment of mechanical seal and bearings without opening casing).

h. Impeller Shaft: The impeller shaft shall be accurately turned and ground to receive renewable shaft sleeves. Free shaft extension to be provided for mounting flexible coupling. The shaft shall be protected by shaft protecting sleeves at bearing location. The impeller shaft shall have Brinell hardness number not less than 230. It shall have a surface finish between 0.75 microns or less. It shall be guided by bearings above and below each impeller. The butting faces of the shaft shall be made machined square to the axis and the shaft ends shall be chamfered on the edges. The shaft shall be straight within 0.125 mm total dial indicator reading for 3 mtr lengths.

i. Line Shaft: The size of the shaft shall be calculated on the basis of maximum

combined shear stress. This shall not exceed 30% of the elastic limit, in tension or 18% of the ultimate tensile strength. The design of the shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% lower, or above the operating speed. The shaft shall be furnished with interchangeable sections having identical normal length. The maximum permissible error in the axial alignment of the thread axis with the axis of the shaft shall be 0.05 mm in 150 mm. Shaft shall be provided with shrunk or snug fitted shaft sleeves of compatible wear/corrosion resistant material, precision ground and polished where pass through bearing.

j. Glands and Seals: The stuffing boxes are to be of sufficient depth and to be soft packed and provided with adjustable bronze glands. It shall be of suitable design, easily detachable with appropriate lubricating arrangements. The stuffing box shall be suitable for repacking by removing the gland and lantern ring.

k. Line Shaft Bearings: Bearings shall be integral with replaceable sleeves of metallic material with suitable securing arrangement in the bearing housing. Bearings shall be self water lubricated.

l. Line shaft coupling: couplings shall be designed with a safety factor of 1.5 times the shaft factor and shall have threads to tighten during pump operation. The outside diameter of the couplings shall be concentric with the bore and with a small transverse hole in the middle.

m. Column pipe: the standard lengths of column pipe shall be 2.5 / 3 mtr. No part in the column pipe such as the flange diameter shall exceed the bowl outside diameter. The column pipe shall be flanged pipes. The size of the column pipe shall be such that the friction loss will be limited to 0.5 m/10 m length at rated capacity. The column pipe section shall be provided with seating lugs, which shall provide temporary support on subbase during lifting operation. This shall enable the column flanges of adjoining section to be assembled on dismantled within the limiting height of the crane hook. Corrosion allowance for column pipe shall be minimum 3 mm.

n. Foundation: pumpsets to be erected on a suitable foundation with necessary foundation bolts, cement concrete etc., complete.

o. Ease of access to the parts to be serviced shall be ensured like mechanical seal cartage type and Bearings, without removing the upper half casing, recourse to disturb either pipe work or prime mover, thereby reducing the downtime for maintenance.
p. Pump shall be provided with Small bore pipe work for Seal flushing.
q. Suction & Discharge connections shall be flanged and shall be drilled *confirming to relevant standard ISO 7005/ IS 6392/ BS 4504/ BSEN 1092.
r. In order to avoid bare metal casing from getting oxidized and to reduce the relative surface roughness of the pump casing, Hydrophobic Coating with properties of good erosion & corrosion protection including protection against cathodic action shall be applied on casing internal surface coming in contact with water. **The coating applied should be suitable for potable water application and certified by Authorized National Lab.**
s. The pump shaft shall be supported by end bearings of anti-friction type,

located on each side of the pump. **Bush bearing will not be accepted**. The bearings shall be of grease lubricated, ball or roller bearing type. The bearing on the pump shall be designed to withstand the unbalanced radial & axial hydraulic thrust. **Bearings shall be designed for L10 life of minimum 50000 hours of operation in the operating range.**

t. The pump shall be designed with such bearing arrangement, to have practically least shaft deflection, so that the initial wearing ring clearance is retained for longer duration for sustained efficiency during operation at the Duty point and in the operating range thereby minimum degradation in hydraulic performance, over the life cycle period when compared to a similar conventional HSC pump with gland packed arrangement.

u. All rotating parts individually and in assembly shall be statically and dynamically balanced to prevent vibration through a range of normal and reverse speeds.

7.4.5.4. **Material Of Construction**

Suction bell	:	CI IS : 210 Gr. FG 260
Bowl	:	CI IS : 210 Gr. FG 260
Impeller	:	SS ASTM A743 CF 8M
Impeller Shaft	:	SS AISI 410 / 431
Line Shaft	:	SS AISI 410/431
Shaft Sleeves	:	SS AISI 410/431
Column pipe	:	MS IS : 2062
Discharge elbow	:	MS IS : 2062
Motor stool	:	CI IS 210 Gr. FG 260
Line shaft bearing	:	Neoprene rubber / Elastomeric
Wearing Ring	:	SS ASTM A 276 Type 304
Shaft Coupling	:	SS AISI 410 / 431
Fasteners	:	SS 304

a) **Documents:** The following documents shall have to be submitted with the delivery:

4 set of O & M manuals: These must contain instructions on how to install and start-up the pump, instructions for maintenance and for trouble shooting (in all complete user Maintenance manual). The supplier shall also impart training to personnel's of the existing O&M contractor about routine and preventive maintenance.

7.4.5.5. **Parameters**

1.	**General**		
i.	Type	:	Vertical Turbine
ii.	Range of flow	:	As per design
iii.	Total Head at design capacity	:	As per design

iv.	Total duration of operation	:	22 hours per day
v.	Minimum operational combined efficiency	:	73%
vi.	Speed	:	Variable
vii.	Applicable code		
	- Design	:	IS : 1710, IS :5120
	- Performance	:	IS : 5120
2.	**Features of construction**		
i.	Internal element	:	Mixed flow impeller
ii.	Type of lubicant	:	Self water lubricated
iii.	Type of sealing	:	Stuffing box gland
iv.	Type of coupling	:	Direct
v.	Number of stages	:	Two maximum
vi.	Column price	:	Dia will be as per requirement and length will be 2.5/3 mtr. Flanged section
vii.	Discharge level with respect to floor	:	As per tender drawing
3	**Accessories and service required**		
i.	Base plate	:	Yes
ii.	Foundation bolts	:	Yes
iii.	Suction strainer	:	Yes
iv.	Companion flanges	:	Yes
v.	Spare parts list	:	Yes
vi.	Maintenance tools	:	Yes
vii.	Start-up/essential spares	:	Yes
viii.	Painting	:	Yes

7.4.5.6. **Testing:**

All the pumps shall be separately tested for performance at manufacturer's works. For testing purpose one of the motors to be supplied along with the pump shall be used.

Standard Running Test shall be conducted as per IS : 5120, at rated speed to measure capacity, total head, efficiency and power. However, no negative tolerance on pump efficiency is acceptable. These tests shall form the basis for pump acceptance except for vibration and noise. The pumps shall be tested over the minimum seven readings approximately equidistant shall be taken for plotting the performance curve.

Material Test Certificate : Bowl, Impeller, Impeller Shaft, Line Shaft, Shaft, Sleeve, Column pipe, Discharge elbow

Ultrasonic Test : Pump bowl and impeller shall be ultrasonically

tested

Hydrostatic Test : 1.5 times the shut-off head or twice the rated discharge head, whichever is greater

Performance Test : As per IS:5120 at full speed

7.4.6. Delivery & Suction Pipes – Design Considerations

The sizes of manifold pipes will not be less than that mentioned in the scope of work. The column pipes, suction pipe and delivery pipes for pumps shall be sized to limit the velocity of flow in respective pipes, below 2 m/sec. The velocity in the suction pipe shall not exceed 1.8 m/s and velocity in delivery pipe shall not be more than 2.0 m/s.

7.4.7. Specifications for Submerged VT Pumps

7.4.7.1. General

a. While superimposing the Q-H pump performance, pump and station losses are to be deducted from it. Accordingly, the pump and station losses are to be added to the pump head at intersection of pump curve and system resistance to arrive at the duty head of the pump. The characteristic curve (Q-H pump performance) for the solo pump, two pump and three pump in operation shall be provided by the supplier.
b. The duty point is to be guaranteed.
c. The approve efficiency with in the approved operating range, at the time of supply, of the pumps installed under the contract shall be maintained throughout the contract period with a permissible reduction of **0.40 %** efficiency per year after 1 year of operation of pump for complete duration of O&M period.
d. The pump set foundations dimensions shall, if required, altered during installation by the bidder and shall also be checked that the pump foundations are suitable for 120% of dead load and 200% of dynamic load for pumps of proposed parameters at design head with existing motors.
e. Out of the total number of pumps supplied under this contract, at least one pump is to be tested for performance test at shop in presence of Procurement Entity's representative. All costs towards inspection shall be borne by the supplier.
f. Q vs. H curves super-imposed on system resistance curves
g. The Contractor will provide as built completion drawings and operation and maintenance manuals at the completion of the works.

7.4.7.2. Codes and standards

The design, manufacture and performance of the pumps specified herein shall comply with the requirements of the latest applicable Codes and Standards.:

The pump set shall be of Compact Unitary construction. The pump casing shall be of high efficiency, Volute Casing type with the Impeller mounted directly onto the Extended Solid Motor Shaft (without any couplings). Nos. of stages shall be decided as per maximum efficiency as per H.I.S.

The pump maybe mounted directly into the water body (Canal / Sump / River or unscreened Jackwell), so it may suck up lot of silt, clay, pebbles & vegetation. Hence it should be reliable & robust.

7.4.7.3. **Pump End Design**

Speed : Speed is required to be decided on achiveable efficeincy of pump.

The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.

The head capacity curve shall be continuously rising towards shut off with the highest at shut off. The shut off head shall be at least 120% of the specified duty point head. the Impeller shall be of high efficiency Multi Channel Enclosed type (except for Specific Speeds ≥ 90 where Semi Open Impellers shall be allowable).

Suction Strainer: The pump is fitted directly with a Suction Bell mouth to which is compulsorily fitted a Heavy duty Strainer (to avoid pick up of gravel, pebbles, vegetation, etc.). As per Documents.

The pump set shall be suitable for starting with delivery valve open as well as closed at any operating point. The motor should also start accordingly. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

Fully filled up & Stamped Data Sheets as per attached format shall be submitted along with the Technical Bid without which the Commercial Bid shall be rejected.

7.4.7.4. **Induction Motor (Submerged) End Design**

The motor shall be of Squirrel Cage, Induction type, Air Filled yet capable of Water Immersion upto 20mwc for S1 duty – Motors with Oil or Water filled windings shall not be allowed.

It is rated for 4l5 ± 10 % V, 3 phase 50 ± 5% c/s A.C. Its winding should be of Class "H" insulation * (withstanding winding hot spot temperature of up to 185°C respectively) while the nominal temp rise of winding hotspot should not exceed that of class "B".

It should be wound using Dual Coated, Super Enamelled; Copper wire with high temperature index as per I.S. 4800 Part-13. PVC / Poly propylene – poly ethylene insulation for winding wires shall not be allowed. Motor's Insulation should be Vacum Varnish Impregnated & Oven Baked to ensure a Moisture Impervious & Mechanically Robust insulation. Dip or Pour type Air Dry Varnishing shall not be allowed.

The Motor Rating should be higher of the two criteria :

- Maximum power consuption through out the range of perfomance at 50 Hz. OR 15% more power consumed at duty point at 50 Hz.

The Motor's Rotor shall be of Dual Cage Copper Bar Brazed type* to assure :

- Long Corrosion free Service life (in presence of high moisture inevitable in submerged motors Aluminum corrodes much faster than Copper),

- Ease of Onsite Repairing &
- beneficial Fly Wheel type Inertial effect (as compared to aluminum rotor, copper rotor is heavy) which reduces detrimental effects of water hammer
- Better Motor Efficiency & Cooler Operating Temperature

7.4.7.5. **Motor Cooling :**

To restrict the Dead Water Level (in case of Vertical Installation) in the Sump to 1m, Medium sized, Vertical pumps (≥55kW) should have a Cooling Jacket – i.e. motor cooling is accomplished by circulation of pumped water between the motor casing & the jacket shell - this jacket shell is fed by cold water from the pump casing & discharges its heated water back into the sump (in case of Wet Installation) or Pump casing (in case of Dry Installation) by integrally cast ducts. There should not be any pipes, hoses, etc for this circulation.

In case the pumps are to be installed horizotally OR the dead water level in the sump exceeds 1.5m from the pump centerline, the motor can be cooled just by water immersion i.e. no jacketing is required. The mode of cooling (either direct immersion or via jacket cooling) should also be clearly mentioned in the data sheets.

7.4.7.6. **Motor Protection**

Thermal Overload Protectors (Bi Metallic Over Load Relays) should be embedded in each phase of the stator winding to detect overheating & trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (above 130°C).

To detect primary Mechanical Seal's Leakage a Moisture Sensor shall be provided in intermediately Oil Chamber (& not in the Motor casing or else where) – this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

7.4.7.7. **Cables**

A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables.

The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length, minimum 10 m to be terminated in an IP 67 junction box (in the scope of electrical contractor) outside adjacent to the wet well & above the HFL. They shall be sized in accordance with the electricity utility regulations and BS 7671.

It should have Power as well as Control Cables of Dual Sheathed EPRS / PVC Armored type with Copper Core of required size as per detail engineering. However the Cross Section of the cable be shall ample enough to ensure a Voltage Drop of not more than 2% at actual site conditions.

7.4.7.8. **Shaft & Bearings**

The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum L10 life of 75,000 hours in accordance with BS 5512. The bearings should be Permanently Greased with Premium Quality, High Temperature, Long Life Grease thereby obviating the need of re-lubrication for upto L10 life of the bearings. The bearing should be of Metric Series & not Imperial ones.

Oil Lubricated bearings shall not be allowed.

In case the motor is to be driven via a VFD, atleast one of the bearings (DE or NDE) should be Current Insulated to prevent "electric fluting damage" caused by Harmonics.

7.4.7.9. **Stuffing Box / Oil Chamber**

The pressurized entry of water into the motor (from the pump's volute casing) should be prevented by Two separate mechanical seals in mounted in a Tandem mode within an oil chamber.

The Primary (Inboard) seal should always be of Silicon Carbide or Tungsten Carbide faces to withstand erosive wear due to any silt particles.

The Secondary (Outboard) seal should be of Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide – i.e. Thermally Unstable materials like Alumina/ Aluminum Oxide shall not be allowed.

7.4.7.10. **Testing**

The pumpsets shall be tested in accordance of ISO 9906, IS 10981, IS 5120 (Tolerance Class 2); with or without VFD

As these pumps may be installed on specialized Auto Coupling Device, where no external bolting between the pump and the delivery piping is possible – so it is absolutely essential that this joint is leak free or else there may be a substantial Pressure/Leakage Loss betweeen the Pump and the Auto Coupling system (as they are not clamped together like conventional Gasketed & Bolted Flanged Joints).So, it is compulsory that the pump should be tested on an Auto Coupling system only- i.e testing the pump with flange, gasket bolted delivery piping is not allowed.

The Flow shall be measured by full Bore Electro-Magnetic or Ultrasonic Flow Meters (of 0.5% or less accuracy class.)

The pumps shall be tested at the manufacturers premises where complete testing facility should be available. Ifmutually agreed the pumps may be tested at the Alternative Test Bed or at Field which the contractor/ manufacturer is bound to offer at no extra cost. The Field Testing shall include the following:

Motor Routine Tests :

IR

HV

No Load Amperes, Vibration, etc.

Pump Performance Testing (in accordance with IS 5120 / IS ISO 9906, Grade 2 -5% / ISO 2548-5%):

Measurement of Head, Discharge, Motor Input at least 6 different points to plot the Actual Performance Curves

All the Extra Charges for such Field Testing shall be borne by the Contractor. It is clarified that, in case of Field Testing Failure; USCL /PHED reserves the right to detain the pumps in their custody until the contractor replaces the failed pumps with new pumps which shall again be subjected to Re-Testing. No extra charges shall be allowed by USCL /PHED to the contractor.

Pump testing should be carried out with VFD. The pump sets are to be used with VFD and the testing has to be conducted compulsorily with VFD (to ascertain compatibility with VFD)

Table : Materials of Construction

Reference Data Sheet for Dry Motor, Wet Installed Submerged Centrifugal Pump sets

Particulars	Specifications
Application	Submerged Centrifugal pump is used for Water Intake/ Transfer / Lift & maybe mounted in Canal, Sump, Lake or Jackwell either Vertically or Horizontally depending upon the site conditions
Type of motor	Squirrel cage induction type with IP68 enclosure
Rated Flow	**As per scope**
Rated Head	**As per scope**
Supply system fault level	20 MVA
Supply neutral	Solidly-earthed
Rated voltage / Rated KW	415 V / Suitable for pump as per previously outlined margin norms
No. of Phases & frequency	3 Phase & 50 Hz.

Pump (Volute) Casing	Motor Casing, Chamber & other parts	Pumps with Duty Point Head rating ≤ 80m & Delivery Size ≤ DN 100mm; Motors ≤ 30kW	Cast Iron (FG 260 as per IS 210 or GG25 or EN-JL1040)
	Motor 's (Squirrel Cage) Rotor	Pumps with Duty Point Head rating ≤ 60m & Delivery Size ≤ DN 125mm Motors > 30kW	Aluminum Die Cast or Dual Cage Copper Bar
	Motor Cooling Jacket (if applicable)	Pumps with Duty Point Head rating > 80m	SS 202 or Epoxy Coated MS
		Pumps with Duty Point Head rating > 60m & Delivery Size > DN 125mm	Ductile Cast Iron or Cast Steel (SG 400/12 or EN-JS1050 or GGG 40 or ASTM 80-55-06 or WCB)
Suction Bell mouth & miscellaneous pump parts			Cast Iron *(FG 260 as per IS 210 or GG25 or EN-JL1040)*
Impeller	Mechanical Seals		Double Mechanical seal shall be fitted. Primary (Inboard) : Silicon Carbide v/s Silicon Carbide or Tungsten Carbide v/s Tungsten Carbide Secondary (Outboard) : Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide
			Cast Austenitic Stainless Steel *(SS 316 or CF 8M or 1.4406)*
Wearing Rings *(Suction Head Casing & Impeller)*			Cast Austenitic Stainless Steel *(SS 316 or CF 8M or 1.4406)* or Bronze
Pump-Motor Shaft			Elastomers: All "O" Rings of Viton only & Bellows of either Viton OR Nitrile Stainless Steel (SS 410 or SS 430 or 1.4021 or 1.4460)* Stainless Steel or Hot Dip Galvanized BHT Alloy steel **Larger Motors (i.e. > 200kW) may be supplied with High Carbon Alloy Steel Shaft (EN 8 or DIN 1.7225 or others) protected with SS 316 Shaft Sleeves*
	Fasteners		
Suction Strainer		Pedestal cum Delivery Bend	Cast Iron (FG 260 as per IS 210 or GG25 or EN-JL1040)
Portable System Stand *(if applicable)*	Auto Coupling *(if applicable)*	Slider Bracket	MS (C15) Fabricated with Epoxy Coating
		Guide Rail	Ductile Cast Iron or Cast Steel (SG 400/12 or EN-JS1050 or GGG 40) or WCB
		Pipes / Wires & Foundation Bolts	MS (C15) Fabricated with Epoxy Coating
			SS 304 Higher grade

Particulars	Specifications
Supply condition	± 10% voltage variation ± 5% frequency variation ± 10% combined voltage and frequency variation
Speed	1500 rpm

Particulars	Specifications
Duty condition as per IS 325 or equivalent	S1 suitable for constant operation
Method of starting	DOL upto 5kW Star Delta upto 15kW ATS for upto 30kW Soft Starter with VFD for above 30 K.W. larger pumps set according to side requirements.
Starting torque & Pull Out Torque	Sufficient enough to start the pump with delivery valve open and when other pumps are running. Sufficient to bring the motor to normal speed in minimum time
Class of Insulation & temp. rise by thermometer	Minimum Class "F" but Temperature rise restricted to that of class "B" i.e. 75°C
Ambient temperature	45° C
Type of Cooling	Surface cooled by circulation of water through jacket shell.
Degree of protection	≥ IP 68 (should withstand upto 20m of Water Immersion) on S1 basis
Cable details	Four Cores (minimum 1/8 cores required as Earth)
Shaft orientation. Horizontal / Vertical	Pump-set should be suitable for Any position – i.e. Vertical or Horizontal or Inclined
Type of bearings	Ball / Roller / Thrust life time lubricated Anti Friction type
Bi Metallic Thermal Over Load Relay for	Yes, one in each phase; for trip, alarming and indicating set to trip @ 130 °C

Particulars	Specifications
Winding required?	
Bearing Over Temperature Detectors	Required for motors > 113kWBy Bi Metallic Overload Thermal Switches set to Trip @ 95 °C
Winding connections	6 Terminals
Standards to be followed	IS 325, 8225, 4889, 4772, 4029, 4691 and other relevant Indian Standard or equivalent BSS. Testing as per ISO 9906 or IS 9137 or IS 5120

7.4.7.11. **Drawings and information to be provided**

During detailed engineering the Bidder shall submit the following:

- General arrangement, cross-sectional and dimensional drawings/data pertaining to selected model.
- Complete performance curve with
- H - Q curves for complete range of impellers between minimum and maximum size of impellers and efficiency curves super imposed on them, highlighting selected impeller diameter.

Instruction Manuals:

- Instruction manual for Erection
- Instruction for pre-commissioning check up, operation, abnormal conditions, maintenance and repair
- Write up on Controls and interlocks provided
- Recommended inspection points and periods of inspection
- Schedule of preventive maintenance
- Ordering information for all replaceable parts

Recommendations for types of lubricants, lubricating points, frequency of lubrication and lubricant changing schedule.

7.4.8. **Specifications for Back wash pumps**

S.N.	Particular	Required Specifications
1.	Make	As per approved list of Makes
2.	Type	Split casing/monoblock centrifugal
3.	Quantity	As per Scope of Work
4.	Duty Condition	As per Scope
5.	Combined Efficiency	60%. For smaller pumps as per IS
6.	Speed	Suitable for 2900/1440 rpm synchronous speed motors
7.	Pump Casing	CI IS: 210 Gr FG-260
8.	Shaft Sleev	S.S.(AISI 410)
9.	Gland	Bronze grade LTB2 of IS 318
10.	Impeller	S.S (CF8M)
11.	Liquid Handled	Potable Water
12.	Temperature	Ambient 45 Deg C (Range 40 to 50 Deg C)

7.4.9. **Dewatering/Drainage and water circulation Pumps**

The bidder shall workout the requirement of the dewatering pumps at Intake, Clear water pumping station and filter plant. Wherever Dewatering pumps are provided they must be provided with 100% stand bye units.

Pumps, if provided for water circulation for cooling must be provided with 100% stand bye units.

These pumps must, comply with following features.

7.4.9.1. **General**

The dewatering pump shall be of suitable capacity and head. The pump motor shall be suitable for working with or without submergence in water. The motor rating shall be more than the maximum power required by the pump.

The pumps shall be electric motor driven.

The pumps shall be vertical, centrifugal, non-clog type. The impeller shall be mounted on the extended shaft of the motor.

The fixed set shall operate manually and automatically controlled by low and high level switches in the drain pit.

7.4.9.2. **Features of construction**

1	Impeller	Bronze Grade LTB II of IS 318
2	Casing	Cast Iron Grade FG 200 of IS 210/ Aluminium as per mfg. Standard
3	Shaft	40C8 of IS 1570
4	Motor	415 V, 3Ph AC supply, submersible

7.4.9.3. **Drawings and information to be provided**

During detailed engineering the Bidder shall submit the following:

- Leaflets on dewatering / water circulating pump.
- Cross sectional drawings with performance curves.

7.4.9.4. **Instruction Manuals:**

- Installation manual for erection
- Instruction for pre-commissioning check up, operation, abnormal conditions, maintenance and repair
- Recommended inspection points and periods of inspection
- Schedule of preventive maintenance
- Ordering information for all replaceable parts
- Recommendations for types of lubricants, lubricating points, frequency of lubrication and lubricant changing schedule.

7.4.10. **Electric hoists**

7.4.10.1. **General**

Electric driven, short headroom, wire rope hoists with motor driven traveling trolley and I-beams for suspension shall be required in

Location	Vertical Lift	Movement area	Capacity	Electrical/ Manual
Chemical House & pump houses	From floor of chemical storage room ground floor to buckets in chemicals tanks floor	From lifting point in floor to all chemical solution tanks	2 ton excluding bucket weight.	Electrical

The construction of the hoists, its components, the design, testing and commissioning shall conform to IS 3938, Class II duty. All parts needing inspection and/or replacement

shall be easily accessible with the minimum need to dismantle other equipment, accessories or structures. All lubrication points shall also be easily accessible without the need for any dismantling of other equipment or accessories. The hoist must be equipped with adequate safety devices. The beam on which the hoist shall travel, shall be designed, supplied, installed and tested in conforming to the relevant Indian Standards.

7.4.10.2. **Mechanical details**

The specifications of the hoists are as follows:

Specifications of the hoists

Rope Drums	Rope drums shall be of cast steel or fabricated from rolled steel plates, conforming to the relevant Indian Standards. Fabricated rope drums shall be stress relieved before any machining takes place. The drum grooves shall be smooth finished and the rope drum shall be flanged at both ends. The drum shall be designed for a single layer of ropes. A precision machined rope guide to suit the drum grooves shall move over the drum like a nut, guiding the rope into the grooves and preventing an overlapping of the rope.
Brakes	Brakes shall be D.C. electromagnetic type/thrust type. Brakes shall be designed to hold the load at any position whenever there is a current interruption, either intentionally or by main power supply failure.
Wire ropes	The wires shall be hemp cored and galvanized. Ropes shall be of regular right hand lay as per IS 2266. The rope construction shall be 6 x 37 with a factor of safety specified as per IS.
Hook block	The sheaves shall be fully encased in close fitting guards fabricated from steel plate. Smooth opening shall be provided in the guards to allow for free movement of the rope. Holes shall be provided for oil drainage. The lifting hook shall be supported on a bearing for 360 ° swivel under load.
Gears and gear box	Straight and helical spur gearing shall be used for all motions. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft. All gears shall be hardened and shall be of tempered alloy steel having metric module. Overhung gears shall not be used. All gearing shall be totally enclosed and grease lubricated.
Trolley wheels	Single flanged wheels shall be mounted in anti-friction roller bearings housed in "L" shaped bearing brackets for ease of removal during routine maintenance. Solid wheels shall be of forged/rolled steel or cast steel.
Motor for hoist and trolley	415 V, 50 Hz, heavy duty motors suitable for hoist and trolley operation, suitable for reversible motion, frequent acceleration and mechanical breaking, totally enclosed, fan cooled, wound rotor motor shall be used. Class of insulation shall be "F", with temperature rise limited that for "B". The pullout torque shall not be less than 225% of full load torque, corresponding to 40% CDF (Cycle Duration Factor of the motor). 200

	switching per hour shall be considered for the selection of motors. The motors shall have the following speed ranges: a) trolley travel: 10 m/min; micro travel: 2 m/min b) hoist: 2 m/min Roller operated, resetting limit switches shall be provided for all motions. Limit switches shall be fitted to prevent over traveling and over hoisting.
Power supply	A flexible traveling cable system mounted on a retracting support system, shall be used. The conductor shall consist of insulated multi-conductor cable with permanent termination on the connection box and on the trolley. The flexible trailing cable shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail along the beam. The flexible copper cable shall be butyl rubber or EPR insulated CSP sheathed type 650/1100 V Grade.
Control	From fixed control panel from where the entire operation area can be overlooked or from a pendant push button control block hanging on a cable from the hoist. Control voltage is 110 V from a single phase step-down transformer. The following control is possible: a) Key operated ON push button - standard green button. b) ON signal lamp - green lens. c) Emergency OFF push button - standard red button. d) Hoisting push button - standard black button. e) Lowering push button - standard yellow button. f) Micro hoisting push button - standard black button. g) Micro lowering push button - standard black button. h) Cross traverse forward push button - standard black button. I) Cross traverse reverse push button - standard black button. j) Micro cross traverse forward push button – standard black button. k) Micro cross traverse reverse push button – standard black button. l) Long traverse forward push button - standard black button.
Beam	The beam shall be suitable for the trolley, complete with end stops, holding down bolts and taper washers and shall be suitable for connection to the station earth. It shall be designed according to the capacity of the hoist, the beam fixation/support points, length and alignment. It shall be of galvanized mild steel. All fixation elements shall be of galvanized steel.

7.4.11. **Specifications of Valves**

7.4.11.1. **General**

The construction features and other specifications of valves shall be as defined in chapter for "Specifications for valves".

7.4.11.2. **Pressure Rating**

The pressure rating of valves must at least be equal to the maximum expected pressure at the point of installation.

7.4.11.3. **Size**

Unless otherwise mentioned, the size of valves must not be less than the size of the respective main (suction, delivery) pipes.

7.4.12. **Ventilation & Cooling of Pump Room**

The ventilation and cooling system of the pump room must be designed such as to limit the temperature rise to a maximum 5 ° Centigrade above the ambient temperature. The ambient temperature is to be taken as 45 ° Centigrade for design of ventilation and cooling system.

The bidder shall provide detailed calculations to determine the temperature of ambient air within the pump room with all pumps in operation.

7.4.13. **Exhaust fans**

7.4.13.1. **General**

Exhaust fans of appropriate rating, in general shall be provided for all openings at the intake and in suitable numbers as per design of clear water pumping station building at clear water pumping station, switchgear rooms, and at floor level 313.00 m. The air change ratio by the selected fan must be provided for the approval of the Engineer–in–Charge, before the selection of exhaust fans.

7.4.13.2. **Technical particulars**

Operating conditions

1	Fan designation	Exhaust duty
2	No. of fans and design capacity	to meet stipulated temperature difference and air circulation levels for limiting temperature rise within specified limits.
3	Type	Wall mounted, centrifugal

Features of construction

1	Impeller	Mild steel or Cast Aluminium
2	Hub	Cast Iron/Die cast Aluminium

3	Casing	Mild steel
4	Wall cowl	Galvanized iron sheet - 22 gauge
5	Bird screen	14 gauge galvanized iron with 12 mm bird screen.
6	Motor	TEFC IP 54, with speed below 1500 rpm synchronous

7.4.13.3. **Drawings and information to be provided**

During detailed engineering the Bidder shall submit the following:

- Leaflets on exhaust fan.

7.4.13.4. **Instruction Manuals:**

- Installation manual for erection
- Instruction for pre-commissioning check up, operation, abnormal conditions, maintenance and repair
- Recommended inspection points and periods of inspection
- Schedule of preventive maintenance
- Ordering information for all replaceable parts
- Recommendations for types of lubricants, lubricating points, frequency of lubrication and lubricant changing schedule.

7.5. **Pipe Fittings**

Pipe fittings of size 50 NB and below shall be forged conforming to IS-1239 Part-II. Fittings above 50 NB up to 200 NB shall be welded/seamless conforming to ASTM A-234 Gr. WP and dimensional standard ANSI B.16.9. Fittings and specials of size 250 NB and above can be fabricated from MS pipes fabricated as per specifications detailed in Chapter 3 of "Specifications for MS pipes".

All specials such as bends, tee's, tapers, etc.. must be fabricated from MS pipes made as per specifications given in Chapter 3. Before fabrication the detailed drawings of fabrication of each special must be got approved from the engineer-in-Charge. All specials must be brought to site after inner and outer coating as specified in Chapter 3 for "Specifications for MS pipes".

7.6. **Cast iron/DI pipes and specials**

The puddle collars embedded in the wall of size less than 600mm will be of DI/ Cast Iron.If flanged DI/cast iron pipes and specials shall be used in the pump houses and to the limit

of both pump station suction and delivery pipelines they shall be manufactured and tested according to IS 1536 and 1537 respectively. Flanges shall conform to IS 1538

7.7. Dismantling joints

The specifications shall be same as specified in Chapter for specifications for pipeline.

7.7.1. Testing and inspection

7.7.1.1. Hydrostatic Test

The entire piping with valves and fittings will be site tested for pressure of 1.5 times the design pressure -.

Duration of testing shall be a minimum of 30 minutes. In case the piping is to be in a network, isolated portions with overlapping areas shall be tested. No pressure drop or leakage shall be evident.

7.8. Chlorination System

7.8.1. Vaccum Feed Gas Chlorinator

1. **The chlorination facilities intended to be provided shall include the following;**
    a. Chlorine tonner container storage for 30 days requirement and handling facilities.
    b. Supply of minimum 4 chlorine tonners with first filling, each of capacity 915kg.
    c. Chlorine gas supply manifold piping system.
    d. Chlorinator room.
    e. Vacuum chlorinators (minimum 1 Working + 1 Standby each for chlorination) with accessories as detailed in the specifications.
    f. Chlorine solution feeding pipelines and diffusers.
    g. Chlorine tonner weighing scales.
    h. Residual chlorine testing and monitoring system.
    i. Chlorine leakage alarm system.
    j. Safety equipments for safe handling and use of Chlorine.
    k. Neutralization Tank.

Not with standing anything herein specified, the bidder shall comply at least the provisions contained in IS 10553 (Part 1 to 2) regarding safety in handling, storage and use of chlorine.

2. **Chlorine tonner container storage and handling facilities**

All chlorine tonner containers shall be stored in the chlorine storage yard. Chlorine tonner storage area location shall be on the prevailing downwind side of the building, away

from entrances, windows, louvers, walkways, etc. No openings between the chlorine storage room and other parts of the building shall be provided. Storage area shall be protected from direct sun light. The storage area shall be roofed with RCC beam and slab without any column inside the storage area. The open area is protected with a steel bar/ chain link fencing of 2 m height. There will be an entrance with gate to unload and load the chlorine gas tonners. A loading and unloading bay of 5 m width shall be provided at the entrance. Space required for the storage and handling of chlorine tonner containers shall be adequate to store minimum 4 nos of chlorine tonners in two rows. Two meters clear space shall be provided between each row of tonner, between end tonner and chlorination room and between each row and the side wall.

A pair of trunnions for each tonner shall be provided to facilitate its rotation for aligning the outlet valve for connecting it with the chlorine gas withdrawal system. A minimum 2 ton capacity EOT crane shall be provided. The gantry must be high enough to pick up a toner from truck and also high enough to lift one cylinder over the other which is on the floor/trunnions. The hoist shall have an automatic brake. It shall have a safety type hook and a suitable lifting beam for the tonner container and an in-built weighing device with a dial indicator. The latter shall be calibrated in a manner to indicate the net weight of the chlorine gas, without the weight of the tonner and the other dead weights. The vertical and the horizontal movement of the hoist shall be controlled from a panel mounted at the wall of the handling bay or from a pendant mounted on the hoist, near the weight indicator.

Two banks of toner containers shall be provided. The toners shall be connected to a separate manifold meant for each bank. Evaporators shall be provided if found necessary as per provisions of relevant BIS and or approved designs in the chlorination room with separate manifolds for liquid chlorine withdrawal from toner to the evaporator.

3. Chlorine tonner Containers

The bidder shall provide minimum 4 chlorine tonners containers fabricated in general conforming to British standard or any other specification of foreign origin. The Specifications adopted have to be approved by Chief Controller of Explosives. The design and fabrication of tonners should also be governed by Gas Cylinder Rules, 1981. The bidder should also arrange license from C.C.E. for Public Health Engineering Department, Government of Rajasthan for processing more than 5 containers at any time under the Gas Cylinder Rules 1981.

Bidder shall also arrange for first filling of Chlorine tonner and transportation for delivery at pumping stations at respective locations without any additional cost to the Employer. He shall furnish all test certificates pertaining to the tonner containers issued by the inspecting authority and approval by the C.C.E..

He shall also supply proper size spanners for opening and closing of tonner valves, adapted and clamp and copper tube connector with each first time chlorine filled tonners.

General specifications: Dimensions & Capacities

a. Water Capacity (Approx.) : 780 kg
b. Chlorine Capacity (Approx.) : 915 kg
c. Design Pressure : 19.9 kg/cm^2
d. Inside Diameter (Approx.) : 860 mm

e. Shell thickness : 10 mm
f. Dished ends thickness : 9.6 mm (min)
g. Overall length (Approx.) : 2085 mm
h. Bare Weight (Approx.) : 520 kg

Container valves

The tonners should be filled with standard valves confirming to IS: 3224-1979 which should also be approved by C.C.E.

4. Chlorinator room

There shall be two compartments in the chlorinator room, one to house chlorinators and other to house boosting system. The chlorinator room area shall be equipped with ventilation equipment capable of one complete air exchange per minute. This equipment shall be located such that it will draw suction near the floor. Exhaust discharge shall be located so as not to contaminate other air inlets to any rooms or structures.

5. Vacuum chlorinators

General Requirements:

The maximum and minimum temperatures at the location should be considered as 49° C and minus 2.2^0 C respectively.
The chlorination facilities are to be designed with the range of chlorination dose between 1 PPM to 5 PPM. Chlorination is to be provided at the CWR.

6. Injector:

The injector may be either of fixed throat type, adjustable throat type or anti syphon fixed throat type. Stop valve, water pressure gauge and measuring device for the water passing through the injector should be provided. Injector water pressure switch for low – water pressure alarm, should also be provided.

7. Water and Booster Pumps for the Chlorinators

The water supply shall be made from the internal system. The pressure shall be boosted by two centrifugal booster pumps to be installed in the Chlorine Building, adjoining to the chlorination room.
At least two working & one standby pumps shall be supplied with isolating valves and the pressure gauges on delivery and suction line and valves by pass with pressure release valve from delivery to suction for each pump. The pump shall be connected to the common pipe fed from the back wash water tank. The pumps shall be identical and suitable for single and parallel operation.
The pumps shall be directly coupled to drive motor by flexible couplings. The pump and the drive motor shall be mounted on a common base plate of steel. Foundation or ground bolts shall be supplied for each base plate.

The drive motor shall be of horizontal spindle, totally enclosed fan cooled squirrel cage motor and shall be manufactured, tested and provided with insulation to class E or better. The rating of the motor shall be at least 20% higher than the maximum power required by the pump over its operating range. The operating voltage of drive motor shall be 415 volts, 3 phase, 50 Hz.

8. Materials of Construction:

Material of construction for various parts of the chlorinator should be as per IS: 10553 Part2 1983 unless otherwise specified by the bidder and approval by the Employer.

9. Chlorine solution feeding pipelines and diffusers

A. Chlorine gas and Solution Piping

The gas and water piping system shall be designed according to the chlorine and injection water flows and the hydraulic/pressure conditions. The pipes shall be laid as straight as possible on the shortest route from the drums to the Chlorinators. They shall be fixed on well-supported trays / brackets and adequately sloped to allow for drainage. All steel supports shall be heavily painted in chlorinated rubber paint.
The connections of the chlorine gas pipes to the cylinders and the Chlorinators shall be coiled for flexibility during operation and maintenance. Each connection shall have a valve, a solenoid valve and a pressure gauge. All pipes and valves of the connection shall be placed out of the reach of gas cylinders hanging on the hook during manipulation.

B. Pipe material for the chlorine dosing plant

Medium	**Construction material**	**Test pressure**
Chlorine gas	Soft seamless copper Tube with compressed fittings	25 kg/cm²
Injector water (With or without boosting)	Galvanized iron pipes And fittings, class C	10 kg/cm²
Chlorine solution	Rigid PVC pipes and Fittings, class 3, not Exposed to open sunlight	10 kg/cm²

7.8.2. **Electrochlorinator**

7.8.2.1. **General**

The water disinfection system shall be installed as per the departmental policy that provides for use of different technologies based upon the quantity of water to be disinfected. However, for mass chlorination, all water transfer pumping stations will be provided with liquid gas chlorination system and local stations will be provided with Electrochlorinator as per volume of water. The provision of installation of electro-

chlorinators at distribution centers is proposed considering that the project area is already significantly populated and due to the hazards associated with liquid chlorine storage and use, as well as due to constraints of space availability at HW's. The capital cost of disinfection system is considered part of Pumping Station Facility and operational cost are proposed under the O&M expenditures. The work includes following but not limited to; Providing, installation, testing and commissioning of Electro-chlorinator capable of producing active chlorine (in house generation) in the form of sodium hypochlorite solution by electrolysis of common salt with crystal solution tank of suitable capacity for brine solution complete with automatic metering cum dosing facility for disinfection of supplied water including supply and installation of dosing pumps of suitable duty points, supply of storage tank of suitable capacity for storage of hypochlorite solution including packing, loading, unloading, transportation laying of inlet and outlet pipe lines and all required electric work including construction of Electrochlorinator room and minor civil works required for installation and commissioning of plant with all consumables. Specifications for 500 gm/hr are given in following paragraphs. The Contractor, after approval from EIC, may install combination of different capacity's electro-chlorinators to meet out the required dosing capacity at different headworks.

7.8.2.2. **General Specifications for Electro-chlorination System - 500 gm/hr**

Fully automatic Electrochlorination system should be in conformity to the following technical specifications:
1. The Electro-chlorination System should be able to generate:

0.5 kg/hr (4.0 kg chlorine generations in 8 hrs) active chlorine from 3 to 5 kg of common crystal salt (equivalent to IS-797 Grade 2) suitable to disinfect 12 MLD water up to @1PPM (6 MLD water @2PPM).
2. The Electrochlorinator System should be able to operate on an input supply of 415 + /- 10 % volt, 3 phase, 50 Hz AC supply including earthing and output of 30-35 D.C. volts, 260 to 300 amps.

3. Suitable capacity dosing pump.

4. Panel Board should be micro processor controlled with proper salinity testing arrangement of brine solution before electrolysis process through reference electrode to be provided. The system should be compatible with SCADA system to be provided by the Department.

5. The system should be automatic and non batch model.

6. The system should be integrated one with the salt storage arrangement for 2 days continuous operation and hypo chlorite storage arrangement for 2 day continuous operations in one unit i.e. the storage system should be for minimum 2 day even if the hypo chlorite solution is not used for these 2 days.

7. Material Construction:

a) Electrolyzer unit comprising the generator and salt storage tank: Engineering plastics

b) Fasteners: SS 416

c) Dosing Pump: PP head (Suction and discharge end)

d) Electrode: Titanium Grade 1 thickness 1.5 mm (as per BIS specification) with DSA (dimensionally stable anodes) technology with suitable MMO coating.

8. Chlorine test kit 0.2 PPM to 5.0 PPM comparative paper chart type of reputed make with testing chemical as required (OT solution) to be supplied for one year.

9. System should have automatic hypo transfer to hypo storage tank.

10. System works on gas lift principal

7.8.2.3. **General Specifications for Electro-chlorination System - 1000 gm/hr**

Fully automatic Electrochlorination system should be in conformity to the following technical specifications:
1. The Electrochlorination System should be able to generate:

1 kg/hr (8.0 kg chlorine generations in 8 hrs) active chlorine from 3 to 5 kg of common crystal salt (equivalent to IS-797 Grade 2) suitable to disinfect 24 MLD water up to @1PPM
2. The Electrochlorinator System should be able to operate on an input supply of 415 + / - 10 % volt, 3 phase, 50 Hz AC supply including earthing and output of 30-35 D.C. volts, 260 to 300 amps.

3. Suitable capacity dosing pump 200 LPH@10kg/cm2 pressure.

4. Panel Board should be micro processor controlled with proper salinity testing arrangement of brine solution before electrolysis process through reference electrode to be provided. The system should be compatible with SCADA system to be provided by the Department.

5. The system should be automatic and non batch model.

6. The system should be integrated one with the salt storage arrangement for 2 days continuous operation and hypo chlorite storage arrangement for 2 day continuous operations in one unit i.e. the storage system should be for minimum 2 day even if the hypo chlorite solution is not used for these 2 days.

7. Material Construction:

a) Electrolyzer unit comprising the generator and salt storage tank: Engineering plastics

b) Fasteners: SS304

c) Dosing Pump: PP head (Suction and discharge end)

d) Electrode: Titanium Grade 1 thickness 1.5 mm (as per ASTM Grade 1 specification) with DSA (dimensionally stable anodes) technology with suitable MMO coating.

8. Chlorine test kit 0.2 PPM to 5 PPM comparative paper chart type of reputed make with testing chemical as required (OT solution) to be supplied for one year.

9. System should have automatic hypo transfer to hypo storage tank.

10. System works on gas lift principal

7.8.2.4. **General Specifications for Electro-chlorination System - 2000 gm/hr**

Fully Automatic Electro Chlorination system should be in conformity with the following technical Specification.
1. The Electro chlorination system should be able to generate :

2.0 Kg/hr (16.0 kg chlorine generations in 8 hrs) active chlorine from 3.5 Kg/Kg of Av.chlorine of common salt (equivalent to IS-797 grade 2) suitable to disinfect 24 MLD water @ 2PPM. The power efficiency should be maximum 4.5 KW/kg of cl2.
2. The electro chlorination system should be able to operate on an input supply of 415+/- 10 % volt, 3 Phase , 50 Hz AC Supply including Earthing and out put of 90 V D.C. volts , 250 Amps.

3. Suitable capacity dosing pump @7kg/cm2 pressure

4. The entire system should be micro processor controlled with proper salinity testing arrangement of brine solution before electrolysis process through reference electrode and indication of less salt.

5. The system should be automatic and continuous dosing models.

6. The system should be integrated one with the salt storage arrangement for 2 days continuous operation and hypo chlorite storage arrangement for 8 hrs continuous Operation in one unit.

7. Material of construction :

a) Electrolyzer unit comprising the generator: Engineering plastics.

b) Salt Storage Tank:HDPE/LLDP

c) Hypo Storage Tank:HDPE/LLDP

d) Fasteners : SS304

e) Dosing pump : PP head (Suction and discharge end)
f) Electrode: Titanium Grade 1 thickness 1.5 mm (as per ASTM Grade 1 specification) with DSA® (dimensionally stable anodes) technology with suitable MMO coating.

8. The system should have automatic hypo transfer to hypo storage tank. Transfer and production of Hypochlorite should stop automatically if hypochlorite level is high in storage tank. However the hypo dosing pump should continue to operate. System operation should resume automatically when the level in hypo storage lowers.

9. The system should work on gas lift principle.

10. The materials shall be dispatched after inspection by the inspection wing of 'RITES' at the manufacturers factory in accordance with the Inspection and test plan. (Copy enclosed).

11. RITES Inspection charges: The inspection charges will be borne by the buyer. The goods will be dispatched after clearance from RITES.

7.9. Miscellaneous

7.9.1. Nuts, Bolts, Studs and Washers

Nuts and bolts shall be of the best quality bright steel, machined on the shank and under the head and nut. Studs, bolts and nuts shall be galvanized. Bolts shall be of accurate length so that only one thread shall show through the nut in the fully tightened conditions. Nuts and bolts shall be ISI Marked and conform to IS 1363 and IS 1367.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary.

Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel bearing stainless steel.

The Bidder shall supply all holding down, alignment levelling bolts complete with anchorages, nuts washers and packing required to fix the plant to its foundations, bed plates, frames and other structural parts.

The Bidder shall procure and keep at site, reasonable excess quantities to cover wastage of those materials which will be normally subject to waste during erection, commissioning and setting to work.

7.9.2. Gaskets

Gaskets shall be of Nitrile rubber and ready made machined cut gaskets for respective flange shall be used. Gaskets cut out from rubber sheet are not acceptable.

7.9.3. Support For Pipework & Valves

All necessary supports, saddles, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valves and other devices mounted in the pipe work shall be supported independent of the pipes to which they connect. Wherever necessary RCC supports shall also be provided

7.9.4. Galvanising

Wherever Galvanising has been specified the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below :

(a) Fabricated steel

	Thickness less than 2 mm but not less than 1.2 mm	340 gm/m2
	Thickness 2 mm and above	460 gm/m2.
(b)	**Fasteners**	
	Up to nominal size M10	270
	Over M10	300

Galvanising shall be carried out after all drilling, punching, cutting bending and welding operations have been carried out. Burrs shall be removed before Galvanising. Any site modification of galvanized parts should be covered well by zinc primer and Aluminium Paint.

7.9.5. **Painting**

Painting of exposed ferrous surface of all items of plant shall be carried out by the Bidder in accordance with provision in the Chapter 7 for "Specifications for Civil Works".

Immediately on arrival at the site all items of plant shall be examined for condition of the primer coat/finish paint applied at the Manufacturer's works and unsatisfactory portions shall be cleaned down to the bare metal, all rust being removed, and the surface made good with similar primer/paint.

After erection, such items which are not finish painted shall be finish painted, items finish painted at the Manufacturer's works shall be touched up for any damaged paint work.

No painting shall be carried out unless the item has been inspected and accepted by Engineer in Charge or the person authorized by him. Shades of finish painting of equipment shall be approved by Engineer-in-Charge.

7.9.6. **Lubrication**

A complete schedule of recommended oils and other lubricants shall be furnished by the Bidder, in the operation and maintenance manuals. The number of types of lubricants shall be kept to a minimum. In case of grease lubricated bearings for electric motors, a lithium base grease is preferred.

The Bidder shall indicate the brand name of indigenously available equivalent lubricants with complete duty specification, to enable the department to arrange procurement in future. The Bidder shall furnish the schedule of quantities for each fill, frequency of filling and annual requirement.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose means more than once in a month.

Where more than one type of special grease is required, a grease gun for each special type shall be supplied.

All lubricant systems shall be designed so as not to cause a fire or pollution hazard.

The Bidder shall supply flushing oil for such lubrication system when an item of plant is ready for preliminary running.

7.9.7. Erection

7.9.7.1. General

The Bidder's staff shall include at least one competent erection engineer who should be at least a graduate with 3 years erection experience and who should be permanent employees of the Bidder, to supervise the erection of the works using sufficient skilled, semi-skilled and unskilled labour and to ensure completion of the Works on time. The Bidder shall not remove any representatives, erectors or skilled labour from the site without the prior approval of the Engineer in Charge

The Bidder's erection staff shall arrive on the site on dates to be agreed by the Engineer in Charge who will give to the Bidders advance notice in writing of the dates on which they will be required. Before they proceed to the site, however, the Bidder shall first satisfy himself, as necessary, that sufficient material of his supply has arrived on site so that there will be no delay on this account.

The Bidder shall be responsible for setting up and erecting the equipment to the line and level required.

7.9.7.2. Leveling And Grouting of Machinery

The pumps and motors shall be properly and accurately leveled and aligned on the concrete plinth by means of tapered metal wedges and metal packing pieces before any grout is poured. After correct alignment and leveling the foundation bolts shall be nipped up to hold the machine firmly in position and it shall be the Bidder's responsibility to check that the position is maintained after the grout has been poured but before it sets. The grout which will contain an approved expanding agent will be mixed and poured by the Bidder. ACC shrinkomph, grout mixer or equivalent as approved by Engineer in Charge, is to be used for grouting.

The horizontality of base plate top shall be within 0.05 mm/meter. The base plate top surface and pump motor box are to be blue matched to get a contact area of at least 80%.

After the grouting mixture has set, the foundation bolts shall be pulled up hard and the alignment and level rechecked. The Engineer in Charge shall be informed at all times of the progress of this work and when any checks on alignment and level are to be carried out so that he may witness the checks if he so requires. The approval of the Engineer in Charge or his intimation that the alignment or level of the machines is to his satisfaction shall in no way relieve the Contract of his obligation under contract to properly install and align the machines and Pipe work and shall in no way prejudice the Engineer in Charge's rights to order rectification of any installation work later found to be improperly carried out.

7.9.8. **Name Plates**

Each main and auxiliary item to the Plant shall have permanently attached to it, in a conspicuous position, a name plate and rating plate, each of weather-resistance and fire-resistance material. Upon these shall be engraved or stamped the manufacturer's name, type and serial number of Plant, details of the loading and duty at which designed to operate.

Details of proposed inscriptions shall be submitted to the Engineer in Charge for approval before any labels are manufactured.

7.9.9. **Miscellaneous requirements**

7.9.9.1. **Nameplates, signboards, nomenclature**

Each item of the plant shall have permanently attached to it in a conspicuous position a nameplate, on which shall be engraved or stamped the manufacturer's name, type and serial number, year of manufacture, details of the design capacity etc. Such labels shall be of non-hygroscopic material to be approved by the Engineer in Charge.

Near by or on each item of the plant, shall be fixed a plate with the name and nomenclature (code) of the item according to the project nomenclature. It shall be visible from a distance of several meters.

The Bidder shall also provide bilingual signboards and instruction tables of durable material, throughout the plant, for the purposes of operation, maintenance and security:

- Danger and caution signs (English and local language)
- Preventive maintenance schedules (local language)
- Operating instructions (local language)
- Unit names (English and local language)
- Nameplates at the doors to the units (English and local language)

Signboards and plates shall be appropriately sized in relation to the relevant item and its surroundings. Details of the proposed inscription, size, material and colors shall be submitted to the Engineer in Charge for approval before any signboards or plates are manufactured. They shall be compatible with the instructions in the operation manual.

All cables shall be provided with clip-on identification numbers on both ends and at all terminations in between, for identification. The nomenclature shall correspond to the electrical as-built drawings.

The nomenclature and labeling of the plant shall be decided in close co-operation with the Engineer in Charge.

7.9.10. **Fire extinguishers**

The Bidder shall provide 12 nos. dry powder type CO2 fire extinguishers (10 kg) for the pumping stations and switchyards at the locations after consultation with the Engineer in Charge at different locations.

7.9.11. **First aid kits**

Complete first aid kits at all the sites shall be provided for the maintenance bays of the pump houses. The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns bad effects of inhalation of chlorine, bad effects on skin due to contact of chemicals acids etc. Following materials in general in sufficient quantities shall be provided.

- Medical cotton, sterile cotton pads
- Cotton Bandages, elastic bandages
- Pair of scissors, packet of new shaving blades
- Sticking plaster for medical use.
- Band aid stripes

Following chemicals/medicines shall be provided in sufficient quantities:

- Tinctures iodine and mercury chrome
- Burnol ointment
- Bottles of spirit and of Dettol
- Toilet soaps

To be procured under medical advice

- Tablets for bad-effects of chlorine inhalation
- Skin lotions and ointments for burns, acid effects

Fire extinguisher and first aid kits shall be provided for the end of the commissioning period only. They shall not be used before and shall be complete.

7.9.12. **Pump House Civil Works**

7.9.12.1. **General**

The work of construction of pump houses is to be carried out along with foundation works for pump/motor/transformer and other equipment, restoration of additional land, finishing works, lighting works etc. as detailed in scope of work.

7.9.12.2. **Pump Houses**

S.No	PARTICULARS	SPECIFICATIONS
1	Pump houses	RCC up to plinth level

S.No	PARTICULARS	SPECIFICATIONS
2	Earth Filling for Reclamation of Land in front of Intake	With suitable earth with compacted density not less than 1.66 Kg/cm3
3	External walls above plinth area	Brick masonry in Cement Sand mortar 1:4
4	Area for office and allied works	Require area as per scope.
5	Internal load bearing Walls	Full Brick in Cement Sand mortar 1:4
6	Partition walls	Half Brick in Cement Sand mortar 1:4
7	Interior Plaster	20 mm thick in Cement Sand mortar 1:4
8	Exterior plaster	Grit wash with white cement
9	Toilet	Glazed tiles upto lintel level and plaster 20 mm thick in Cement Sand mortar 1:4 above
10	Flooring	
	Pump/motor Room	Floor Hardener topping with CC base
	Switchgear Room	PVC flooring with CC flooring base
	Battery room/ Battery Charger room/Operator office space/ duty room/ stairs / office space/toilets and other areas	Kota Stone
	Control room	PVC flooring with CC flooring base
	Corridors and new stairs from rehabilitated areas	Kota stone with marble strip border
11	Painting	

S.No	PARTICULARS	SPECIFICATIONS
	Inner areas of pump/motor room, office area and lobbies	Acrylic Distemper
	Control room	Plastic Emulsion Paint
12	Doors	
	Control room	Glass paneled Aluminum door shutters with aluminum frame and single panel hinged shutters with door closures.
	Main Entrance Doors	Glass paneled Aluminum door shutters with aluminum frame and double panel hinged shutters with door closures.
	Switchgear room	Glass paneled Aluminum door shutters with aluminum frame and single panel hinged shutters with door closures.
	Toilet and other areas	Pressed steel frame with 35 mm thick flush doors shutter
13	Windows	
	On Outer Front Walls and other windows opening in main entrances	Glass paneled Aluminum shutters with aluminum frame and double panel shutters. (All windows in Control room will be fixed without shutters of same specifications)
	Other Windows	steel section window with wire gauge and safety grill
14	Cooling Arrangement	

S.No	PARTICULARS	SPECIFICATIONS
	Entrance lobby	Fans
	Office rooms	Fans and Coolers
	Control room	Fans
15	Roof Treatment	Brick bat coba with Water proofing treatment

7.10. SPECIFICATIONS OF PVC SUBMERSIBLE CABLE 1.5 Sq. mm to 50 Sq.mm, ISI marked (IS 694-1990) (Amended up to date)

7.10.1. SCOPE

These specification cover the supply of ISI marked three core flexible flat PVC insulated and PVC Sheathed joint less cable conforming to IS 694: 1990 (amended upto date) to be used with the submersible pumping sets inside and outside water for working voltage upto and including 1100 volts. **However, in case of cable size more than 10.0 mm, a single joint at a distance of 3.0 meter from pump set shall be permissible having minimum size 10.0 mm towards pump set**. These cables are to be used as cables suitable for outdoor use having bunched plain high conductivity copper conductor conforming to IS: 8130-1984 (amended up to date) and insulated and sheathed with PVC compound conforming to IS: 5831-1984 (amended upto date).

7.10.2. MATERIAL OF CONSTRUCTION

7.10.2.1. COPPER CONDUCTOR

The bunched conductor shall be composed of plain annealed high conductivity copper wires complying with Class 5 of Copper Conductor as per IS 8130-1984 (amended upto date). The nominal max. diameter of wires and corresponding minimum number of wires in a strand and maximum allowable resistance shall be as follows:

S. No.	Size of cablein sq. mm	Maximum dia. & corresponding wires in a core		Max. resistance of conductors at 20^{O} centigrade (ohms/Km.)
		Maximum dia. in mm	Minimum No. of wiresincore	
1	1.5	0.26	29	13.30
2	2.5	0.26	47	7.98

3	4.0	0.31	53	4.95
4	6.0	0.31	80	3.30
5	10.0	0.41	76	1.91
6	16.0	0.41	122	1.21
7	25.0	0.41	190	0.78
8	35.0	0.41	266	0.554
9	50.0	0.41	379	0.386

NOTE: THE CROSS-SECTIONAL AREA OF EVERY CORE SHOULD BE SAME AS PER PRESCRIBED SIZE OF CABLE (WHEN CALCULATED ON THE BASIS OF DIA OF EACH WIRE & NUMBER OF WIRES IN A CORE).

7.10.2.2. **INSULATION&SHEATH**

The insulation shall be of PVC compound conforming to the requirement type `A' of IS5831:1984 (Specification for PVC insulation and sheath of electric cable) (amended upto date). The sheath shall be of PVC compound conforming to the requirement of type ST-I of IS: 5831-1984 (amended upto date). Cores shall be identified by different coloringofPVCinsulation. Colour of cores shall be identified by Red, Yellow and Blue and the colour of sheath shall be Black only. Three cores shall be laid side by side. Average thickness of insulation shall not be less than the nominal value (t_i) mentioned below and the smallest of measured values of thickness of insulation shall not fall below the nominal value t_i mentioned below by more than (0.1mm + 0.1 t_i).

The sheath where applicable, shall be applied by extrusion. It shall be applied over the laid upcores. It shall be so applied that it fits closely on the laid upcores and it shall be possible to remove it without damage to the insulation. The thickness of sheath determined by taking the average of a number of measurements, shall not be less than the nominal value (t_S) specified below, and smallest of the measured values shall not fall below the nominal value (t_S) specified below by more than 0.2 mm + 0.2 t_S.

S. No.	Size of cable (mm^2)	Nominal thickness of insulation (mm) (t_i)	Nominal thickness of sheaths (mm)
1	1.5	0.6	0.9
2	2.5	0.7	1.0
3	4.0	0.8	1.1
4	6.0	0.8	1.1
5	10.0	1.0	1.2
6	16.0	1.0	1.3
7	25.0	1.2	1.5
8	35.0	1.2	1.6
9	50.0	1.4	1.7

7.10.3. **TESTING**

7.10.3.1. **ACCEPTANCE TESTS**

The following tests shall constitute acceptance tests:

S.No.	Test	Test method as per
(A)	Annealing Test (for copper)	Part No. 1 of IS: 10810
(B)	Conductor Resistance Test	Part No. 5 of IS: 10810
(C)	Test for thickness of insulation and sheath.	Part No. 6 of IS: 10810
(D)	Tensile strength and elongation at break of insulation and sheath.	Part No. 7 of IS: 10810
(E)	Insulation resistance test	Part No. 43 of IS: 10810
(F)	High Voltage Test	Clause 16.3 of IS: 694 The cable shall withstand without breakdown an ac voltage of 3 kV (rms) or a dc voltage of 7.2 kV applied for a period of 5 minutes for each test connection.
(G)	Flammability test	Clause 16.5 of IS: 694 & Part No. 53 of IS: 10810 (The period of burning after removal of flame shall not exceed 60 seconds and the unaffected (uncharged) portion from the lower edge of the top clamp shall be atleast 50mm).

7.10.3.2. **ROUTINE TESTS**

The following shall constitute routine tests;

a) Conductor resistance test and b) High voltage test.

7.10.3.3. **TYPE TEST**

The following tests shall constitute type tests:

S.No.	Type Test	For Requirements, Ref	Test Method
a)	Tests on Conductor		
	i) Annealing Test (for copper)	IS 8130: 1984	As per Part 1 of IS: 10810
	ii) Resistance Test	IS8130:1984	As per Part 5 of IS: 10810
b)	Test for overall dimensions Thickness of insulation and sheath	10, 13, 14 Table 1 to 5 of IS8130: 1984	As per Part 6 of IS: 10810

c)	Physical tests for insulation and sheath		
	i) Tensile strength and elongation at break	IS 5831: 1984	As per Part 7 of IS: 10810
	ii) Loss of mass test	IS 5831: 1984	As per Part No. 10 of IS: 10810
	iii) Ageing in air oven	IS 5831: 1984	As per Part No. 11 of IS: 10810
	iv) Shrinkage test	IS 5831: 1984	As per Part No. 12 of IS: 10810
	v) Heat Shock test	IS 5831: 1984	As per Part No. 14 of IS: 10810
	vi)Hot deformation	IS 5831: 1984	As per Part No. 15 of IS: 10810
d)	Insulation resistance	IS 5831: 1984	As per Part No. 43 of IS: 10810
e)	High voltage test (Water immersion test)	16.2 of IS 694	As per Part No. 45 of IS: 10810 i. Ac test The core(s) shall be carefully removed from a sample approximately 3 M long from the finished cable. They shall be so immersed in a water bath at 60 ± 3 degree C that their ends protrude at least 200 mm above the water level. After 24 hours, a voltage of 3 kV (rms) shall be applied between conductors and water. This voltage shall be raised to 6 kV (rms) within 10 seconds and held constant at this value for 5 minutes. If the sample fails in this test, one more sample shall be subjected to this test, which should pass. **ii) dc test** The cores which have passed the preliminary test mentioned above shall be subsequently tested witha dc voltage of 1.2 kV in the same water bath at the same temperature. The conductors shall be connected to the negative pole and water to the positive pole of dc supply by means of a copper electrode. The core shall withstand this dc voltage test for 240 hours without breakdown. The voltage shall be applied continuously, but if there are any unavoidable interruptions during the 4 hours period, that period shall be increased by the time of interruptions. The total of such interruption shall not exceed 1 hour otherwise the test shall be started again.
f)	Flammability test	16.5 of IS 694	As per Part 53 of IS: 10810
g)	Cold bend test for diameter <=12.5mm	IS 5831: 1984	As per Part No. 20 of IS: 10810

h)	Cold impact test for diameter more than 12.5 mm	IS 5831: 1984	As per Part No. 21 of IS: 10810

S.No.	Type Test	For Requirements, Ref	Test Method
i)	Additional ageing test	16.6 of IS 694	**Ageing of Sample** A sample, 6 mtrs. long of the finished cable shall be suspended in a heating chamber and exposed to a temperature of 80 ± 2 degree C during a period of 168 hours. Immediately after this, the sample shall be placed in a bath of boiling water for a period of 8 hours and in a water bath at $25^{O}C$ for 16 hours. This procedure shall be repeated on 5 successive days. The ends of the sample shall protrude at least 200 mm above the water level. Testing and Evaluation A sample, 5 mtrs. long, taken from the conditioned sample shall be tested for high voltage test in accordance with clause 16.3 of IS 694: 1990. The test has however, to be carried out on the finished cable and in a water bath at 60 ± 3 degree C. The remaining conditioned sample shall be submitted to cold bend and cold impact test as appropriate.

The inspection including stage inspection and testing of the material shall be got done by the inspecting agency at the works of manufacturer. All acceptance test mentioned above shall be conducted by inspecting agency.

7.10.4. **SAMPLING OF CABLES:**

- LOT

In any consignment the cables of the same size and type manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

A) SCALE OF SAMPLING

Samples shall be taken and tested from each lot for as certaining the conformity of the lot to the requirements of the specification.

The number of samples to be selected shall depend on column 2 & 3 of following table. These samples shall be taken at random:

S.No.	Number of drums in lot	Number of drums to be taken as sample	Permissible number of defectives
1	2	3	4
1	Upto 25	3	0
2	26 to 50	5	0
3	51 to 100	8	0
4	101 to 300	13	1
5	301 & above	20	1

B) In order to ensure the randomness of selection, procedure given in IS4905: 1968 may be followed.

C) NUMBER OF TESTS AND CRITERION FOR CONFORMITY:

From each of the drum selected according to column 2 & 3 of above table, suitable length softest samples shall be taken. These tests samples shall be subjected to each of the acceptance tests. A test sample is called defective if it fails in any one of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number given In column 4 of above table, the lot shall be declared as confirming to the requirements of the acceptance tests ;otherwise not.

7.10.5. **PACKING AND MARKING**

The cable shall be supplied in non-return able wooden drums with adequate barrel diameter and shall be packed in such a manner that it shall be protected from injury and damages during transit. Not more than one length shall be wounded on one drum.

7.10.5.1. **The cable shall carry following information and contained in label attached to pumpset:**

a) Reference to IS 694

b) Manufacturer's Name, Brand Name of trademark. c) Type of Cable and Voltage grade.

d) Number of Cores.

e) Nominal core sectional area of conductor.

f) Length of Cable.

g) Cable code (yy)

h) Year of Manufacture. i) No. of wire in a core

The manufacturer shall identify throughout the length of Cable the Manufacturer's name or trade mark and the word " USCL - PHED" by means of embossing on the cable. The distance between any two consecutive printing or embossing should not be more than one meter. The cable shall also be marked with standard mark.

NOTE :(i) Wherever there is reference of Indian Standard it shall be considered amended upto date at the time of inspection of supply/ replacement by inspecting agency. Any amendment shall be effective only when it is implemented by B.I.S.

7.11. CHECK LIST FOR INSPECTION OF SUBMERSIBLE PUMPSETS

OBJECTIVES:

Inspection of Submersible Pump sets as per *IS 8034* (amended/ revised uptodate) and PHED's specifications with objectives to:

- Ensure compliance to the contract requirement by vendor in terms of material of construction/workmanship etc.

- Check performance parameters in terms of Head/ Capacity/ Efficiency as per PHED's specifications.

- Minimize probability of failure at site.

RAW MATERIAL CHECK:

Correlate material certificates to ensure that quality material has been used in respect of major components- (Chemical/ physicaltesting)

- Bowl casting

- Impellers

- Shaft material

- Motor casing pipe

Sub-vendor (Bought out items):

Check for approved make/ model/sourcing of motor winding wires, stampings, various castings, lead cables etc.

Check of material properties for conformance to specification by drawing random samples from components at 1.1 &1.2 in the event of any doubt.

IN-PROCESS/ WORKMANSHIP/ CHECKS:

Verification of vendor's own Q.A. system for incoming items/ bought out item's Inspection and accept ance criteria.

Check vendor's records of dimensions of major components & verify same on random basis w.r.t. vendor's drawings.

Check internal records of hydro-test in respect of pressure containing parts followed by random witness.

Check surface finish & hardness requirements of ground shafts, bearings pads, wearrings, internal grinding of bush bearings on random basis.

Verification of vendor's records of running clearances and random check.

Epoxy painting quality check of wetted parts of pump &motor randomly to verify paint thickness.

Check positive locking of stampings

The motor windings should have been manufactured after vacuum impregnation, air drying or pressure impregnation system.

Check thrust bearings of motor. These shall be tilting pads type resting on S.S. balls. Check tilting action by hand. Hardness of thrust bearings pads should be verified on random sample.

Check dynamic balancing records of vendor and randomly check/verify balancing & calibration of balancing machine.

SUB-VENDOR/BOUGHTOUTITEM'SINSPECTION: CHECK:

Major items such as winding wire, stampings, castings, lead wires etc. should be of reputed make or as specified in Purchase Order (ifany).

Review manufacturer test certificates and their co-relation.

Check to ensure sub-vendor has carried out all testing as per relevant specification.

MOTOR TESTS/ CHECKS:

Check H.V. testing of coils after immersion in water for minimum 4 hrs.

100% H.V.tests and insulation resistance tests for 12 hrs after immersing in water in all motors by vendor.

100% motors routine tests as per IS-9283 &IS-325 by vendor. Records of test to be submitted for review of Inspection Authority.

Type Test of motor- Heat run- Test for each lot/ type, at minimum voltage for performance.

PERFORMANCE TEST CHECKS:

Sampling plan as per *IS: 10572/ IS: 8034* (number of samples shall be in accordance with pumpsets offered in one lot for inspection)

Performance test procedure set up as per *IS: 8034/ IS:11346*

Check calibration of various measuring instrumentation to measure head, flowrate, power consumption etc.

Check correct direction of rotation and that the same is marked.

Run pump for one hour at duty point prior to recording readings for performance.

Witnessing performance test in terms of head, flowrate, pump efficiency at rated volts and minimum voltage specified for motor for at least 4 hours on the selected sample.

STRIPCHECK:

OBJECTIVES:

To check for any damage during the running of pumpset specially with regard to wearing parts

To check general workmanship/ surface finish of bearings/ castings etc

Check Running Clearances are within specified limits

Check for locking arrangement of wearing rings, lock-nuts etc.

PROCEDURES:

Pump-motor set shall be completely dismantled after performance test.

All components with relative movement shall be visually checked for any objectionable rubbing/wear/scoringmarks.

To check all running clearances/ play to ensure they are within specified tolerance.

To check shaft/ rotor run out is within design specified limits.

Check for peeling of rotor paint/ rusting etc.

MARKING:

MARKING: The marking shall be as per relevant IS code and as per BEE guidelines (for 5 star rated pump sets). The pump set shall invariably be marked with BIS standard mark and BEE standard mark (for 5 star rated pumpsets). Purchasers mark ` USCL - PHED.' & `Year of Supply' shall also be mentioned on each pump & motor.

NOTE: Wherever reference of IS number/ BEE marking is given it may be treated as amended/ revised upto date at the time of inspection of supply/ replacement by inspection agency. Any amendment/ revision shall be effective only when it is implemented by BIS/ BEE.

7.12. SCOPEOFWORKOFINSPECTIONOFPVCSUBMERSIBLE CABLE

7.12.1. SCOPEOFWORK

The copper conductor of PVC submersible cable shall be confirming to IS: 8130-1984 (amended upto date). The PVC cable should be jointless insulated and sheathed with PVC compound confirming to IS 5831-1984 (amended upto date). However, in case of cable size more than 10.0 sqmm, as in gle joint at a distance of 3.0 meter from pump set shall be permissible having minimum size 10.0 sqmm towards pumpset. The inspection shall be carried out as per the provisions incorporated in the relevant Indian standards. Inspection of submersible cable for working voltage upto and including 1100 volts.

7.12.2. SAMPLING

As per relevant Indian Standards/ Specifications of Bid.

Following checks/ tests shall be carried out by the inspection agency: ACCEPTANCE TESTS

S.No.	Test	Test method as per

(A)	Annealing Test (for copper)	Part No. 1 of IS:10810
(B)	Conductor Resistance Test	Part No. 5 of IS:10810
(C)	Test for thickness of insulation and sheath.	Part No. 6 of IS:10810
(D)	Tensile strength and elongation at break of insulation and sheath.	Part No. 7 of IS:10810
(E)	Insulation resistance test	Part No. 43 of IS:10810
(F)	High Voltage Test	Clause 16.3 of IS:694 The cable shall withstand without breakdown an ac voltage of 3 kV (rms) or a dc voltage of 7.2 kV applied for a period of 5 minutes for each Test connection.
(G)	Flammability test	Clause 16.5 of IS: 694 &Part No.53 of IS:10810 (The period of burning after removal of flame shall not exceed 60 seconds and the unaffected (uncharged) portion from the lower edge of the top clamp shall be atleast 50mm).

NOTE: In case of incorporation of further new acceptance test in relevant IS: Same shall become part of above tests automatically.

- Inspection & evaluation of Type Tests reports for submersible cable shown by the manufacturer as per provision of clause No.4 of appendix `C' (Specifications).
- Inspection & evaluation of test certificates regarding routine tests & acceptance of raw material shown by the manufacturer (copies to be appended with inspection notes).
- Inspection agency is to confirm following information on each drum of submersible cable:

a) Reference to IS694

b) Manufacturer's Name, Brand Name of trademark. c) Type of Cable and Voltage grade.

d) Number of Cores.

e) Nominal core sectional area of conductor. f) Length of Cable.

g) Cable code (yy)

h) Direction of rotation of drum (By means of arrow)

i) Year of Manufacture.

j) Approximate gross weight. k) No. of wire in a core

- MARKING: Marking in token of inspection and acceptance by inspection shall be made in following manner:

    (a) All samples selected by inspection agency shall be differentiated by putting two inspection seals.

- Inspection agency has to submit copies of test result as mentioned in para-3 and inspection sheets to purchasing authority as well as concerning consignees.
- Details of Rejection, if any.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 8. Specification for Pumping Station (Electrical)

8.1. General

It is not the intent to specify herein all the details pertaining to the design, drawing, selection of equipment/materials, procurement, manufacture, installation, testing & commissioning, however, the same shall be of high standard of engineering and shall comply with all currently applicable standards, regulations & safety codes. These specifications cover the equipment to be installed in transmission line, switchgear, sub station, control equipments, cables etc. along with the specifications for workmanship, laying cables, earthing systems, lightning protection etc.

It shall be the responsibility of the Bidder to design the electrical system based on the selection of the mechanical equipment. The work will be executed as per the detailed designs and drawings approved during execution. The equipment / material installed at headworks shall commensurate with those installed by the contractor constructing the pump house building.

Wherever the electrical equipment and system has to be connected with the Instrumentation system, the details of the connectivity of the electrical system/equipment with the Instrumentation system has to be worked out by the bidder to be commensurate with the requirement of the Instrumentation system to be provided, Irrespective of the provisions given in these specifications for electrical equipment/works, in this chapter. The bidder shall provide all necessary accessories with the equipment dealt herein or additional equipment required for effective functioning of the electrical and Instrumentation systems.

The pre-dispatch inspection and pre-commissioning testing and commissioning details are provided in the Chapters of Specifications for Pre-dispatch inspection and Specifications for Testing, Commissioning and Trial run respectively.

The brief technical specifications of the various electrical equipments are given in subsequent clauses comprising the following:

- Applicable Indian Standards
- Other considerations (if any)

- ❖ Technical parameters supplied by the department
- ❖ Drawings and documents for review/approval

The various systems covering the installation practices are described separately.

The scope of the Bidder shall cover design and drawing of electrical systems, selection of the equipment/materials, procurement, expediting, inspection, packing and forwarding, delivery at site, erection, testing, commissioning, obtaining the statutory approvals, handing over the complete plant etc.

8.2. **Ring Main Unit**

8.2.1. **Standards and mechanical data**

Metal Enclosed switchgear:	IEC 62271-200
General Purpose switches:	IEC 60265-1
Disconnectors and Earthing switches:	IEC 62271-102
Switch Fuse Combination:	IEC 62271-105
Circuit Breakers:	IEC 62271-100
Common clauses:	IEC 60694
Pressure of SF6 gas:	1.4 bar at 20 °C
Cable bushings:	DIN 47636
Temperature class:	-25 °C - +40 °C outdoor
Degree of protection:	
- SF6 tank:	IP 67
- Fusecanisters:	IP 67
- Front cover:	IP 2X
- Cable cover:	IP 3X
- Enclosure	IP 54
Busbars:	240 mm2 Cu
Earth bar (external):	120 mm2 Cu - Bolt dimension: M10
Thickness of Stainless Steel Tank:	2.5 mm

Colours:

- Front cover: RAL 7035

- Side and cable cover: RAL 7035

- Enclosure IS 632

8.2.2. **Electrical Data**

Nominal voltage: 11 kV

Rated frequency: 50 Hz

Rated current busbars: 630 A

Rated current cable switch disconnector : 630 A

Short time withstand current:

- cable switch disconnector with interface C (400-bolt) bushing: 20 kArms 3 sec.

- vacuum circuit breaker with interface C (400-bolt) bushing: 20 kArms 3 sec.

Rated current for transformer T-off : 630 A

Impulse withstand voltage :

To earth and between phases: 75 kV

Insulation level:

- Power frequency 1 min: 28 kV

8.2.3. **Load Break Switch**

1	Cable switch 12kV, 630A
1	Manometer
1	Snap action mech. for manual operation
1	Cable cover standard with Interlocking
1	Cable bushings interface C (400 bolted), 630 A, standard
1	Capacitive voltage indication fixed type VPIS 9-15 kV
1	Cable support bars, standard for 1-way unit

8.2.4. **Vaccum Circuit Breaker**

1	Vacuum circuit breaker 12kV, 630A
1	Stored energy mech. for manual operation
1	Cable cover standard with Interlocking
1	Self Powered Over Current and Earth Fault protection relay type ADR141S
1	Cable bushings interface C (400 bolted), 630A
1	Aux. switch for vacuum circuit breaker position 2NO + 2NC
1	Capacitive voltage indication fixed type VPIS 6-12 kV
1	Cable support bars, standard for 1-way unit
3	Ring core currenttransformer type 50/1 A, 2.5VA, 10P10 for protection

8.3. **Power Supply Information**

The proposed power supplies are as follows:

1	11 KV AC System	Voltage variation +10 to -15% Freq. Variation +3 to -5%	Three Phase and neutral, 50 Hz, effectively earthed system, SC. rating of 100 mva
2	415V AC System	Voltage variation +10 to -15% Freq. Variation +3 to -5%	Three Phase and neutral, 50 Hz, effectively earthed system, SC. rating of 50 kA
3	240V AC System	Voltage variation + 10% to -15 % Freq. Variation + 3% to - 5%	Single phase and neutral, 50 Hz, effectively earthed system

The ambient temperature for design of the electrical equipment shall be 50° C.

8.3.1. **Fault Levels**

The fault levels of the proposed units in the sub station / pump house shall be as per IS:2026 as follows:

11 kV system : 100 MVA

415 V system : 20 MVA

8.3.1.1. **General**

The electrical installations proposed under the contract are for the project requirement. Wherever found necessary, the installations shall be done considering the likely extension of the system/system component for integration with the future extensions.

8.3.1.2. **Pumping Station**

8.3.2. **Inspection.**

Besides USCL /PHED officers, Engineer from Electric Supply Co. of JVVNL O&M Circle may also visit the work & record inspection note being expert agency for such works. Directions/ suggestions given by the authority shall have to be complied with.

8.3.3. **Miscellaneous**

The specifications mentioned above cover broad outlines of transmission line and this is not the limit of specifications and therefore contractor shall not limit above mentioned specification but shall design and formulate the transmission line as per standards and practice in electric company of Rajasthan.

8.3.3.1. **Transformers**

The bidder shall design the required capacity of the transformers. 100% stand by capacity transformers with allied equipment and structures shall be provided and installed at the SUB-STATION as per the single line diagram (SLD) in drawing annexed. Sub station design .

The design of transformer shall consider the following:

a. The loads of the proposed LT motors at Clear water pumping station along with all other auxiliary loads of the equipment & lighting in pump house, and other load in campus and other buildings /structures in the campus area.
b. Load factor of 0.90 for the LT motors and 1.25 for lighting fixtures shall be considered, with a power factor and efficiency of motors to be taken as per data sheet approved by EIC.

Subject to the above requirements, a minimum of 2 transformers of capacity as per SLD is to be provided along with RMU (RING MAIN UNIT) in the each SUB-STATION. Prior to the transformer, suitable capacity VCB, CT, PT and earthing arrangements shall be provided as per standards.

8.3.4. **Requirements of Protections and Metering at pumping station(s)**

8.3.4.1. **Protections**

Following protection / relays are proposed for incomer, transformers, motors and other plant feeders.

Feeders For 433 V system

MCCB

MCB

8.3.4.2. **Transformer Alarm and Trip**

The following meters shall be provided

- On L.V side of transformers, Ammeter with selector switch
  - Over Current
  - Earth Fault
  - Winding Temperature
  - Oil temperature
  - Oil level

8.3.5. **Power Transformers**

8.3.5.1. **Standards**

No	Standard	Description
1	IS **1180**	Specification for power transformer
2	IS 2099	Specification for bushing for alternating voltages above 10000V
3	IS 3347	Specification for porcelain transformer bushing

8.3.5.2. **Other considerations**

The main transformer shall be complete with an off load tap changing, and all other accessories. For auxiliary transformers, off load tap-changing arrangements shall be provided.

Requirements of Indian Electricity Rules should be fulfilled wherever required.

8.3.6. **Technical parameters**

8.3.6.1. **Transformer Particulars**

1.	Application	Power distribution
2.	Nos. & Rating and voltage ratio of each unit	As per scope- 2 Nos. with step down Voltage , 11Kv/0.433Kv

3.	Percentage Impedance (subject to IS tolerance)	**As per IS 1180 Level 1**
4.	Cooling method	ONAN
5.	3 Phase unit/single phase unit	Three phase single unit
6.	Winding material	Aluminium
7.	Type of winding	Delta – Star
8.	Vector Group	Dyn11
9.	Fault Level on HV side for 11kV/0.44 kV	100 MVA
10	Neutral earthing of LV system	Solidly earthed
11	Whether fully insulated	Yes
12	Impulse voltage withstand on 11 kV	-
13	Power Frequency withstand voltage for 11 kV	28 KV for 11 Kv line
14	Temp. rise of oil by Thermometer	40^0 C over ambient
15	Temp. rise of winding by resistance	45^0 C over ambient
16	Tapping on winding	HV
17	Total Tapping Range & step range	+5% to - 10% in step of 2.5%
18	HV side termination suitable for 11 kV/0.44 kV transformer	11 kV grade XLPE cable
19	LV side termination suitability suitable 11 kV/0.44 kV transformer	1.1 kV grade $3^1/_2$" core armored AYFY cable
20	LV wdg. neutral end	Additional bushing for external system earthing
21	Installation	Outdoor
22	Colour shade of final painting as per IS 5	Yes - (Shade No. 632)

8.3.6.2. **Accessories**

a.	WTI with 2 mercury contacts for 11/0.44 kV transformers **Not**Required
b.	OTI with 2 mercury contacts for 11/0.44 kV transformers **Not**Required

c.	MOG with 1 mercury contact for 11/0.44 kV transformers only	**Not**Required
d.	Silica gel breather	Required
e.	Oil conservator tank	Required
f.	Pressure relief valve for 11/0.44 kV transformers only	Required
g.	Lifting lugs	Required
h.	Tap position indicator for 11/0.44 kV transformers only	Required
i.	Oil drain cum sampling valve for 11/0.44 kV transformers only	Required
j.	Air release drive for 11/0.44 kV transformers only	Required
k.	Explosion vent	Required
l.	Skids	Required
m.	Wheels	plain wheels

8.3.6.3. **Drawing and documents required**

- GA drawing of the complete transformer
- Foundation drawing for transformer
- GA drawings for bus duct termination(if provided), marshalling box
- Schematics and wiring diagrams for MB
- Instruction manual for installation, operation and maintenance

8.3.7. **LT Motors for pumps, Dewatering Pumps, other motors not dealt in other sections of rating more than 2 kW**

8.3.7.1. **Standards**

No.	Standard	Description
1.	IS 325	Squirrel cage induction motors

2.	IS 4691	Type of enclosures
3.	IS 6362	Method of cooling
4.	IS 4029	Testing of induction motors
5	IS 12075	Mechanical vibrations of rotating electrical machines
6	IS 12065	Permissible limits of noise level

8.3.7.2. **Other considerations**

Bidder shall select the motor as per the required performance of the pumps and ascertain the required rating of the motor. Bidder shall also verify the starting characteristic and acceleration time for motor selection.

The bidder shall inform the number of permissible restarts (hot & cold) per hour for each motor, after obtaining the same from the motor manufacturer.

If cable termination box provided with the motor is inadequate to accept required no. of cables, then the Bidder shall provide an adopter box for the same. The cable termination box location shall be as per the layout drawings

8.3.7.3. **Technical parameters**

1.	Tentative motor details	As per System Requirement
2.	Type of motors	TEFC Squirrel cage induction motors
3.	Protection Class	min. IP 42
4.	Motor duty	Continuous, S1
5.	Supply voltage & frequency conditions	Voltage : 415 V +10% to -15% Frequency : 50 Hz +3% to -5% Combined variation : + 10% to -15%
6.	Insulation class	Class F temp. rise limited to Class B.
7.	Frame Size	Frame size should be selected keeping in view supply voltage and frequency conditions/hot and cold starts.
8.	Syn. speed	as per driven equipment
9.	Starting Current	Starting current as per IS.
10	Cable termination details	Cable termination box protection class IP 52.
11	Earthing conductor	GI strip as per the sizes specified

12 Performance details	Energy efficieny as per IS-12615 (IE3 efficiency class)
13 Painting details	Enamel paint of shade 631 as per IS 5.

8.3.7.4. **Drawing and documents required**

- ❖ GA drawing of the each motor showing dimensional details and terminal box details
- ❖ Motor selection details
- ❖ Motor Characteristics
- ❖ Instruction manual for installation, operation and maintenance for motors

8.3.8. **Soft Starters**

8.3.8.1. **Soft starters above 50kW**

Microprocessor Based three phase SCR controlled Soft starter incorporating the latest technologies and designed to provide a complete range of the most advanced Soft start, Soft stop & motor protection features.

The soft starter shall have both the option of Normal Voltage Ramp and Torque Ramp. With the TORQUE Control option motor should start and stop with more linear acceleration.

The minimum standard built in features should be:

1. **Soft Start:**

   1 – 30 sec site adjustable

   Kick start to over ride soft start for high torque, kick start level & time site selectable.

   Voltage & Current control start.

2. **Soft Stop:**

   0 – 30 sec site selectable

   Soft stop control: through selectable Step down & End Voltage level during stop ramp to prevent water hammering.

3. **Power Connection:**

   6 wire (Inside Delta) connection with motor

Bypass facility through built in power terminals of soft starter, however built in motor protections should remain active during bypass as well.

4. Motor Protection:

Below mentioned Microprocessor based protection should be available

Overload protection, with Trip class 10A/10/20/30, site selectable.

Dual Overload relay to select different trip class during start & normal run

Motor Over temperature

Starter Over temperature

Phase Imbalance

Phase Sequence

Instantaneous High Current

Under load

Motor Connection

Phase Loss

Frequency fault

Shorted or Open SCR

Soft starter PCB fault

Communication failure

4. Warnings: Below mentioned pre warnings before tripping should be available

Motor Over Load

Thyristor Over Load

High Current

Low Current

6. Operator Interface:

Digital Key pad with LCD screen for at least 20 segment Display

Local Push button for Start, Stop, Reset to be provided

RYB Phase, Start, Stop, Trip LED indications

Start, Stop, two programmable Inputs

Motor Thermistor PTC input for monitoring motor temp. & protection

Three programmable Relay Outputs

Motor current settings:- 30% to 115%

Flexible communication option:- Modbus / Profibus / Devicenet / ASI

7. General Technical Details:

a) Mains Input Voltage	: 3 Phase 230 – 500 Volt +10%, -15%
b) Supply Voltage	: 100 – 250V AC 50/60 Hz
c) Supply Frequency	: 50 Hz (+ 2 Hz)
d) Rated Insulation Voltage	: 690 Volt
e) Surges	: 2 kV Line to Earth, 1 kV Line to Line
f) Fast Transients	: 2 kV / 5 kHz
g) Enclosure	: IP42
h) Operational Voltage	: 0 to 50 deg.C.
i) Relative Humidity	: 5 – 95%
j) Standard Markings & Approvals	: CE, UL, CSA
k) Type Test	: Type testing as per IEC 60947-4-2
l) Service Factor	: 115% of Soft starter rated current

8. Other Features:

a) Current Read out

b) Motor Temperature Read out

c) SCR Temperature Read out

d) Event Log, minimum 20 history to be available

e) Auto Restart Delay

f) Auto / Manual Reset

g) No. of Start Counter

h) Motor Running Hour Counter

i) Password Protection

j) Store/ Restore / View Changed settings

k) Built in Cooling Fans

8.3.9. VFD (Variable Frequency Drive)

8.3.9.1. Construction and Performance Features

The VFD should work efficiently at ambient temperature of 50 degree centigrade. The VFD must also be protected and interlocked by a main circuit breaker, which is located in front of the primary side of the converter transformer. The circuit breaker must be able to interrupt a drive fault within the specified time. Due to safety reasons, if required the circuit breaker has to be controlled entirely by the VFD. The breaker must also be able to open based on a trip signal from the drive.

A detailed wiring diagram shall be provided showing the starting interlock, trip circuit, starting and running mode signals. It shall be possible to manually start the motor locally from the Local control panel or in `Auto' mode through the PLC.

VFD Set/System shall be complete with the following as per explained system configuration:

a) VFD Panel for each pump
b) Transformer associated with VFD at 11KV supply
c) Incoming Breaker at 11KV supply side
d) Protection for Motor
e) HSC Pump Motor.
f) Local Control Panel
g) Special Tools and Tackles required for the erection, testing, commissioning, operation and maintenance of Complete System
h) Bidder's scope of work includes design, engineering, manufacturing, shop testing, inspection of bought out items and supply of all electrical equipment.

i) Pump motor shall be fed from VFD system which includes input converter transformer. Protection and Metering for VFD system shall be as per attached specifications for VFD system and referred codes and standards. VFD panel shall be located in the sub-station. Harmonics are to be controlled as per IEEE 519. The overall power factor of the drives at 100% load shall be more than 0.98. Any other accessory, fixing hardware, switches etc. which shall be required for satisfactory operation and completeness shall be provided by bidder. Type test certificates and utility consumption list shall be submitted at the time of Inspection to the employer. Inspection and Testing at works shall be as per VSD specification.

These specification covers design, manufacturing, testing at works, packing and supply of Low Voltage (1.1KV), AC Variable Frequency Drive system. The VFD system shall be compatible with Squirrel Cage Induction Motor as specified in specification and complete with converter, converter input transformer, DC link reactor with associated auxiliaries, harmonic filters, isolators, field mounted local control panel etc. as detailed below.

8.3.9.2. **General**

The Vendor shall be responsible for engineering and functioning of the complete system, meeting the requirement of this specification and data sheets. This shall include but not be limited to inverter sizing, input transformer sizing, transformer impedance selection, vector group, input and output harmonic filter as required by applicable standards, design and sizing, output dv/dt filter sizing, isolator rating, motor cable selection/ sizing and motor sizing / selection.

8.3.9.3. **Site Conditions**

I. The VFD and all other associated equipments shall be suitable for operating satisfactorily in humid atmosphere. Ambient temperature: 5 to 50 Degree Centigrade. Humidity: 95%

II. The VFD drive Panels & VCBs shall be installed indoors in a non-hazardous room. The Transformer associated with VFD shall be of outdoor type and shall be

installed in outdoor substation. Motor shall be installed with HSC Pump in Head Works (Pump House). The bidder shall furnish the required clearances in VFD room including layout, earthing requirement and adequate ventilation system for VFD Panel, for efficient and reliable operation of the VFD.

III. VFD system shall be designed for Operation of a HSC Pump which shall be in operation continuously, However VFD should also takes care of change in load, start / stop in different load conditions without affecting the performance of the system.

8.3.9.4. **Applicable Codes and Standards**

The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified.

IS-3700: Essential ratings and characteristic of semi-conductor devices

IS-3715 : Letter symbols for semi-conducting devices

IS-4411: Code of designation of semi-conducting devices

IS-5001: Guide for preparation of drawings for semi-conductor devices

IS-5469: Code of practice for the use of semi-conductor junction devices

IS-6297 : Transformers and indicators for electronic equipment

IS-8789 : Performance parameters for motors

IS-12729 : Switchgear and control gear for voltages exceeding 1000V- General requirements

IEC 146 : Semi Conductor converters

IEC 297 : Dimension of panels and racks

IEC 326: General requirements and measuring methods for printed wiring boards

IEC 352 : Solder less wrapped connection

IEEE 444 : Protection standards for converters

IEEE 519 : Harmonic control & reactive compensation of static power converters DIN 41488 : Electrical engineering dimensions

In case Indian standards are not available for any particular equipment, standards issued by IEC/BS/VDE/ IEEE/ NEMA / UL/FM/CE shall be applicable.

8.3.9.5. **General Requirements**

a. Bidder shall ensure availability of spare parts and maintenance support services for the offered equipment for at least for 15 years from the date of Installation.

b. VFD manufacturer should have their maintenance service & spares supply network in India to provide quick maintenance service & Spares supply support. The bidder should ensure that VFD supplier / Manufacturer services are available as and when called for during installation, commissioning, testing and O&M period till completion of contract period.

c. Bidder shall ensure proper coordination with the driven equipment supplier in selection / sizing of offered variable frequency drive system.

8.3.9.6. **Technical Requirement**

Performance Requirement

The performance characteristics are not limited to following points only. Bidder can give better performance than the points given here.

I. The system shall be fully digital, Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion, low vibration , low wear and low noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.

II. The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with maximum input supply voltage variation of +/-10% and frequency variation of +/-3%. The system shall be suitable for the load characteristics and the operational duty of the driven equipment i.e. HSC Pump.

III. It shall be capable of withstanding the thermal and dynamic stresses and the transient
mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.

IV. The drive system shall be designed to operate in such a way that VFD — HSC Pump system should give best performance in various load conditions to ensure pump operation.

V. The drive controller shall be equipped with microprocessor based digital regulator with

programmable functions. The power control regulator logic shall provide for an acceleration / deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable as per pump & Motor characteristics.

VI. The system shall be suitable for HSC Pump operation and the speed variation shall be within range 10-110% with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed.

VII. Harmonics should be recommendations in the latest edition of IEEE-519. And IEC 61800-4 and it should not affect the motor performance.

VIII. Unless otherwise specified, the overload capacity of the controller shall be 150% of rated current of motor for one minute for constant torque applications, and 115 % of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demand exceeds the current limit for more than 1 minute, the drive shall shut down to prevent over heating of the motor and damage to the drive.

IX. The drive shall trip in case the speed exceeds 110% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.

X. Maximum noise level from the drive at 1-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 dBA.

XI. Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for startup adjustments and troubleshooting / maintenance.

XII. Voltage at Motor Neutral shall be maintained at ground potential for the total operating condition.

XIII. Motor space heater supply of 240 V, with appropriate heater capacity is to be provided in VFD Panel interlocked with VFD Run command i.e. when Motor is running, motor space heater shall be OFF and when Motor is stopped, motor space heater shall be ON.

8.3.9.7. **Control Requirement**

1. The adequate control system to be provided considering the latest applicable standards and norms for reliable, efficient and consistent performance of the HSC Pump.

2. Short time voltage dips up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.
3. The system shall be suitable for number of starts as per the specifications of the Motor.
4. The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
5. The drive motor shall be speed controlled corresponding to 4-20 mA reference input signal.
6. It shall be possible to vary the speed of the drive in either Local or Remote mode. Local / Remote selection shall be from VFD panel unless otherwise specified.
7. VFD should have capability to interface with remote PLC/SCADA . Should have required DI/DO/AI/AO with potential free contacts and transducers.

8.3.9.8. **Panel**

1. VFD panel should be made as per latest applicable standards and at least have IP-4X.
2. VFD should be minimum 24 pulse and suitable for Motor which is driving to HSC Pump. VFD should ensure the efficient, reliable and continuous operation of HSC pump in various speed and load conditions.
3. Bus bars shall be of electrolytic copper/aluminum, color coded separately for AC and DC system.
4. The panel shall include suitable semi conducting power devices (Diodes/IGBT/IGCT/SGCT) modules with protective devices, reactors, filters, control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall be the design requirement of integrated standards. All necessary safety precautions, identification, name plates etc shall be the considered in Panel.
5. VFD Panel consists of associated measurement, protection and annunciation system for VFD, Incoming Transformer, incoming Breaker and HSC pump motor etc.
6. Power and control cabling, Power & Control Modules etc shall be as per applicable standards.

7. Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

8.3.9.9. **Cooling**

1. The drive panel shall be naturally air cooled as per manufacturer's standards. If unavoidable, forced type-cooling system shall be provided. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without over hearting.
2. Necessary starter shall be provided with in the VFD panels for the Panel Ventilation fans and any other auxiliary motors etc. The system provided shall be interfaced with drive starting and shut down such that safety interlocks such as Start Permissive from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc. shall be incorporated in the overall sequence logic.

8.3.10. **Capacitors**

8.3.10.1. **LT Capacitors**

8.3.10.1.1. **Standards**

Standard	Description
IS 2834	Power factor improvement capacitors

8.3.10.1.2. **Other considerations**

The Contractor shall check with manufacturer regarding providing of inductor coil.

The Contractor shall work out the power factor control scheme to achieve a power factor of 0.98. The power factor improving capacitor requirement shall be as per the power factor of the equipment selected by the Contractor.

8.3.10.1.3. **Technical parameters**

a)	Quantity and output	The quantity and output must be designed as per the requirement of load to achieve the objective.
b)	Capacitor type	MPP
c)	Rated voltage and frequency	415 Volts 3 phase (line to line), 50 Hz

d)	Maximum over voltage the unit capacitor is capable of withstanding continuously	105 %

8.3.10.1.4. **Drawing and documents required**

- GA drawing of the capacitor unit, bank
- Instruction manual for installation, operation and maintenance for capacitor

8.3.11. **Cables**

8.3.11.1. **LT Cables**

8.3.11.1.1. **Standards**

No.	Standard	Description
1.	IS 1554	PVC insulated electric Cables.
2.	IS 8130	Conductors for insulated electric cables.
3.	IS 5831	PVC insulation and sheath of electric cables.
4.	IS 3975	Mild steel wires, strips and tapes for armouring of cables.
5.	IS 1753	Aluminium conductors for insulated cables.

8.3.11.1.2. **Other Considerations**

Power cable shall be of Al conductor, whereas control and lighting cables shall be of Cu conductor. The minimum size of Al conductor cable shall be 4 mm2 and Cu conductor cable of 2.5 mm2.

Power cable sizing shall be based on the various de-rating factors recommended by cable manufacturer, rated current, temperature rise of conductor and voltage drop.

Control cables of CTs shall be based on the VA burden of CT and relays, meters.

8.3.11.1.3. **Technical parameters**

LT Cables	PVC insulated, taped PVC inner sheath and outer sheath 650/1100 V grade, with multi-stranded aluminium/copper conductor, armoured
Cable selection	Cable shall be selected considering following points Current rating of the load De-rating due to grouping of cables. Voltage drop up to 3% in cable due to cable resistance

	De-rating factor due to ambient temperature. De-rating due to depth in case of buried cables
Spare cores for control cables	Up to 4 cores - nil 5 cores to 9 cores - 1 core 10 cores to 20 cores - 2 core 21 cores to 30 cores - 3 core More than 30 cores - 4 core

8.3.11.1.4. **Drawing and documents required**

- Cable catalogue

8.3.11.2. **HT Cables**

8.3.11.2.1. **Standards**

No.	Indian standard	Description
1.	IS 7098	XLPE insulated electric Cables.
2.	IS 5831	PVC insulation and sheath of electric cables.
3.	IS 3975	Mild steel wires, strips and tapes for armouring of cables.
4.	IS 1753	Aluminium conductors for installation cables.

8.3.11.2.2. **Other Considerations**

The HT Cable sizing shall be passed on 100 MVA at 3.3 KV. The short circuit withstand duration shall be 1.0 sec for all breaker feeders and 0.7 sec for HRC fuse control feeders.

HT cable shall be of 3.3 KV, on earth grade.

8.3.11.2.3. **Technical Parameters**

HT Cables	3 core, Aluminium conductor, XLPE insulated, armoured.
Cable Size	As per design

8.3.11.2.4. **Drawing and documents required**

- Cable catalogue

8.3.12. **Cabling System**

8.3.12.1. **Installation**

The cables shall be laid in trenches, trays or conduits or shall be buried in ground. Cable routings shall be checked at site to avoid interference with structures already provided in the pump house, piping and ducting. All cables shall be carefully measured and cut to the required length, leaving sufficient length for final connections to the equipment on both ends.

The Bidder shall ascertain the exact requirement of cable, for a particular feeder, by measuring at site along the actual finalised route.

Cables shall be laid in complete uncut lengths from one item of equipment to another.

Cables shall be neatly arranged in the trenches, trays in such a manner, that criss-crossing is avoided and final take off to the motor, switchgear is facilitated. LT Cables shall be laid a maximum two layers in each tray for cables up to 3 ½ C x 95 mm2. Arrangement of cables within the trench, tray shall be the responsibility of the Bidder.

Power and control cables shall be laid on different trays in one trench. 1.1 kV grade cable may be laid on one tray.

All cables shall be identified close to their termination point by cable numbers. Cable numbers will be punched on aluminium straps, (2 mm thick), securely fastened to the cable and wrapped around it.

Underground cables shall be provided with cable markers. These cable marker posts shall be located at every 50 metres and every corner or change of direction.

All temporary ends of cables shall be protected against dust and moisture to prevent damage to the insulation. While laying cables, the ends shall be taped with PVC tape.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with protective cover until the final termination to the equipment is completed.

Directly buried cable shall be laid underground in excavated cable trenches wherever required. The trenches shall be suitably designed for accommodating all the cables. Before cables are placed, the trench bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. The cable shall be covered with 150 mm of sand over the top of the largest dia. cable and sand shall be lightly pressed. A protective covering of RCC tiles shall then be laid on top in case of HT cable and ordinary brick in case of LT cables. The balance trench area shall then be back filled with soil, rammed and levelled.

As each cable is laid in the trench, it shall be subjected to an insulation test in the presence of the Engineer in Charge before covering. Any cable which proves defective shall be replaced at no additional cost.

All wall openings shall be effectively sealed after installation of cables.

Where cables rise from trenches to motors, control stations, lighting panels etc., they shall be taken up in GI pipes (rigid, flexible) for mechanical protection up to a minimum of 600 mm above grade level. The diameter of the GI pipe shall be at least 3 times the diameter of the cable.

Cable shall be carefully pulled through conduits to prevent damage.

Wherever cables are taken in conduits, pipe, the Bidder shall ensure that the area of conduit, pipe is at least 100 % more than the cable area.

If pipe sleeves installed are inadequate due to a greater number of cables being laid, then additional pipe sleeves shall be laid. After the cables are installed and all testing is complete, conduit ends above grade level shall be plugged with suitable weatherproof plastic compound.

Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same.

At road crossings and other places where cables enter pipe sleeves an adequate bed of sand shall be given.

Cables installed above grade level shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel to, or at right angles to, beams, walls or columns. The cables shall be so routed that they will not be subjected to heat.

Cables running along with structures will be clamped by means of GI saddles and saddle bars at a spacing of 300 mm.

Cable carrier systems i.e. site fabricated ladder type cable trays and supporting steel shall be painted before laying of cables. Painting shall have two coats of red oxide and one coat of Aluminium paint.

For all outdoor buried cables a 3 metre diameter loop shall be provided at both ends before termination.

8.3.12.2. **Termination**

All XLPE insulated cables shall be terminated using HT termination kit only

All PVC cables shall be terminated at the equipment/panel by means of double compression type brass glands and tinned copper lugs.

Power cable cores shall be identified with red, yellow and blue PVC tapes.

In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per inter-connection diagrams, to be furnished to the Bidder.

The cable shall be taken through an adequate size gland inside the panel or any other electrical equipment.

Cable leads shall be terminated at the equipment terminals by means of crimped type solderless connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping.

8.3.12.3. **Testing of cables**

Before energizing, the insulation resistance shall be measured from phase to phase and phase to ground.

8.3.13. **Earthing System**

8.3.13.1. **General**

Earthing of all non-current carrying metal work of starters, motors etc. shall be earthed. Chemical Earth/Plate earthing shall be used for earthing. All the material required for the earthing system shall be supplied and installed by the Bidder. The bidder shall integrate instrument earthing with the general earthing system of the pump house.

All the material required for making earthing stations, such as electrode,chemical, charcoal, salt etc. shall be supplied by the Bidder. Excavation and refilling for laying of earth strip and for earth pit shall also be in Bidders scope.

- The entire earthing system shall fully comply with Indian electricity act and rules. The Bidder shall carry out all changes desired by the electrical inspector, in order to make the installation conform to I.E. Rules.
- Conduits in which cables have been installed shall be bonded and earthed. Cable armours shall be earthed at both ends.
- All electrical equipment above 230 V shall be earthed at two points and equipment
  230 V and below shall be earthed at one point.

Conductor size for connections to various equipment shall be as per the table as follows:

Equipment		Conductor Size
Motors	Up to 11 kW 11 kW up to 22 kW 22 kW up to 37.5 kW 37.5 kW to 90 kW 90 kW to 200 kW Above 200 kW	8 SWG GI wire 4 SWG GI wire 25 x 3 mm GI flat 25 x 6 mm GI flat 40 x 6 mm GI flat 50 x 10 mm GI flat
Panel up to 300 A		40 x 6 mm GI flat
DG UP TO 125 KVA		40 x 6 mm GI flat
Local control station, street light pole & its junction box		8 SWG GI wire
Lighting Panel		25 x 3 mm GI flat
Indoor fixtures		14 SWG GI wire

- All paint, scale etc. shall be removed before earthing connections are made.
- Anchor bolts or fixing bolts shall not be used for earthing connections.

8.3.14. **Miscellaneous**

8.3.14.1. **Cable glands and lugs**

All HT cables shall be terminated with HT cable termination kit of indoor or outdoor type depending on the application.

All LT cable glands shall be made out of brass and shall be of double compression type.

All LT cable lugs shall be of tinned copper, crimping type.

8.3.14.2. **Cable trays**

Cable carrier system shall comprise of site fabricated ladder type cable trays made out of structural steel and painted with two coats of red oxide primer and a final coat of enamel paint. The construction of the cable trays shall be as per the site requirement and generally in line with the tender drawings.

8.3.14.3. **Insulating Mat**

Electrical grade insulating mats shall be provided in the switchgear room in front of all panels as per latest BIS.

8.3.14.4. **Civil Works**

The civil works required for electrical installation will also be part of this package. The bidder shall also co-ordinate all inter-disciplinary interfaces between civil and electrical works.

8.3.14.5. **Local Push-button (PB) Stations**

Construction	Outdoor type weatherproof
Main pump motor	On-off with ammeter
Other motors	On-off
Valve motors	Forward-stop –reverse spring return starter with indication for full open/close position of valve.

8.3.14.6. **Spare parts for Electrical Equipment**

The compulsory spare parts shall be provided as per the list enclosed under scope of work.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be labelled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

8.3.15. **Lighting System**

8.3.15.1. **Scope**

This part of specifications covers supply and installation of all equipment necessary for a complete lighting and receptacle systems at Pump House, Clear Water Pump House, rehabilitated buildings, in campus areas etc. The type of lighting fixtures and receptacles shall be LED. The illumination level and approximate quantity required shall be detailed by the contractor before execution of works so as to achieve the required criteria of clause 7.2.14.4.2.

8.3.15.2. **Drawings and Data**

- The contractor shall furnish relevant descriptive and illustrative literature on lighting fixtures and accessories dimensioned drawings/ data for the respective lighting fixtures with manufacturer's catalogue numbers.
- It shall be the responsibility of the contractor to work out a detailed layouts in order to provide the level of installations as indicated under Design Criteria and shall be furnished for the approval of the Engineer-in-Charge before commencement of installation.

8.3.15.3. **General Requirements**

8.3.15.3.1. The lighting system includes the following items

8.3.15.3.2. Lighting fixtures complete with lamps and accessories

8.3.15.3.3. Lightng System equipment including he following;

8.3.15.3.4. Light control switches, receptable units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system.

8.3.15.3.5. Lighting Fixture supports, street lighting poles and flood light towers.

8.3.15.3.6. Lighting main distribution board, lighting panels.

8.3.15.3.7. Multi core cables for street, boundary and flood lighting.

8.3.15.3.8. Provision of automatic on-off road switches through solar system.

8.3.15.4. **Design Requirement**

8.3.15.4.1. **Lighting Layout**

It shall be responsibility of the contractor to work out a detailed layouts for different units/areas in order to provide the levels of illumination as indicated in the design requirement above. The contractor shall be responsible for measuring the levels of illumination after installation and establish compliance with the specification.

8.3.15.4.2. **Levels of illumination**

The design, manufacture and performance of equipment shall conform to the latest Indian standard.

Lighting system shal be designed considering following lux levels.

Pump Houses

1. Pump room area	150 Lux
2. Maintenance bays	250 Lux
3. Electrical Control room	250 Lux
4. Control Room	250 Lux
5. Duty Room	250 Lux
6. Area in front of building	50 Lux
7. Surrounding areas	10 Lux
8. Cellar below Control room	100 Lux
Campus Areas	
9. Front gate of campus and Other main crossings	50 Lux
10. Along the campus roads	20 Lux
11. Along Campus Boundary	20 Lux
Office buildings	
12. Rooms	250 Lux
13. Corridors & Stairs	100 Lux
14. Bathroom	100 Lux
15. Area in front of building	50 Lux
16. Surrounding areas	20 Lux
Residential buildings	
17. Rooms	250 Lux
18. Corridors & Stairs	150 Lux
19. Bathroom	100 Lux
20. Area in front of building	50 Lux
21. Surrounding areas	20 Lux

Chief Executive Officer
Udaipur Smart City Limited

Chapter 9. Ancillary Civil Works

9.1. General

This part of specifications covers, development of campus areas at treatment Plant head works, , construction of Residential & office buildings, construction of boundary walls; drainage; electrification & horticulture works.

The specification for material / workmanship / testing for the construction of new buildings and lighting, campus works etc. shall be in conformity to the specifications laid down in the chapter for " Specifications for Civil Works" in this volume of the bid document.

9.2. Preparatory Work

The proposals presented in this tender document are based on departmental concept. The details of the morphology are to be checked by the Contractor before making the final layout plan of the units of the head works / where the structures etc. are to be located. The head works land has to be graded as per the approved site plan during execution so as to provide good landscaping and to avoid flooding of campus areas. Whenever there is an abrupt change in levels the sides/boundaries of the land allotted shall be neatly dressed with side slopes 1V: 3H. Surplus earth, if any, shall be disposed of as per directions of the Engineer-in-Charge.

The Contractor shall provide and maintain a benchmark with a level and at a location approved by the Engineer in Charge. All levels shall be deemed to refer to that benchmark. The Contractor may establish other secondary benchmarks on the site.

During all stages of preparation, design and construction the Contractor has to cooperate with the other Contractors working on the same site.

9.2.1. Topographical Survey

Before taking up the works of planning head works details, a detailed topographical survey shall be conducted of the head works and surrounding areas. The extent of survey shall be governed by the nearest drainage point for effluent drainage out of the campus through campus drainage system. Topographical and contour maps shall be prepared for the entire head works area and the drainage out let point to scale agreed with the Engineer in Charge. The topographic map shall show all existing details at head works such as buildings, drains, electrical lines, transformers, roads, trees etc.

The contour maps shall be prepared with contour interval of 0.25 meter.

9.2.2. **Soil Investigation**

The Contractor in co-ordination with the Engineer in Charge has to determine at each location of a building or water retaining structure the soil characteristics (safe bearing capacity, angle of friction, cohesion) in order to calculate the dimensions of the foundations. It is also important to assess the potential of rise in water level, erosion and exposure of foundations and the stability of the soil with view to the lateral resistance to be taken into account.

The contractor shall determine the proctor density of the embankment material(s) and shall submit the laboratory moisture – density curves for the proposed fill earth(s). The required soil analyses are:

a. Penetration tests
   - Standard penetration test to a depth corresponding to at least 1.5 times the width of the building/foundation; at least 3 tests per building/reservoir; distance between the penetration points less than 20 m

b. Plate load tests:
   - to assess soil bearing capacity at the foundation level (Plate test)
   - to take samples for laboratory analyses

c. Pile Test
   - As per IS 2911 for each structure proposed with pile foundation in the head works.

d. Laboratory analyses for different burrow areas
   - granulometry
   - Liquid and plastic limit
   - cohesion
   - angle of friction

Chemical contents, dry density, optimum moisture content, permeability, maximum dry density at OMC and degree of compaction required for achieving maximum dry density through proctor test, Tri-axial tests and other recognized tests from a recognized laboratory

Any other tests required to determine the design parameters of the structures/embankments

At least 3 test pits shall be made for each site of a building/tank/structure., preferably after having fixed the location of the building. The distance should be less than 20 m.

If the standard penetration tests give a sufficiently clear picture of the soil bearing capacity the number of test pits can be reduced.

In addition the following soil data have to be provided from the test pits:

- composition and classification of the soil (sand, clay, silt, organic matter etc, soft, medium, hard, decomposed rock, rock etc.) with view to:
- excavation
- need to support walls of trenches
- compacting
- permanent or temporary groundwater (water logging)

- hard pans below the sand (depth, thickness, type of layer)
- clay lenses

Cube Crushing Tests for Rocks

For the areas where the foundation is to be laid on rock, samples of rocks shall be taken for preparation of cubes. The cubes will than be tested for their crushing strength for the weakest section (i.e. by application of load along the bedding angle) and safe bearing capacity shall be determined using suitable factor of safety. At least 3 samples for a site shall be tested.

The results of the survey, the sampling, the laboratory analyses and the calculations have to be presented in a report in three copies to the Engineer in Charge. The execution of the foundations shall be started only after approval of the Engineer in Charge. The contractor however will be responsible for design of the structures/earthen embankments based on these investigations.

Along with the excavation for the buildings and reservoirs the Contractor has to assess / complete the type of soil, the strata, the level of groundwater and other important indicators. He has to establish soil profiles and submit these to the Engineer in Charge for approval.

9.2.3. **Detailed design**

The various design parameters indicated in the following paras and elsewhere cover only the main parameters, other provisions of the relevant IS or as per good engineering practices however shall also be applicable. Based on his layout design, approved by Engineer-in -Charge, the investigation results, the Contractor has to prepare the final detailed design, according to the latest Indian Standards, the specifications mentioned here in the tender documents, good engineering practices and the instructions of the Engineer in Charge.

The detailed designs, architectural and structural design has to be prepared in close co-ordination with the Engineer in Charge. It will be approved by him. Placement of order, manufacturing or construction can start only after the approval. The approval procedures have to be followed as prescribed in the Special Conditions of Contract and as agreed upon with the Engineer in Charge.

9.3. **Campus Development**

The campus area treatment head works are to be developed which includes landscaping, construction of boundary wall, providing interior roads, piping and infrastructure for potable water, electrification of campus area, providing drainage system, providing gates, development of gardens, plantation of trees etc.

9.3.1. **Preparatory Works**

The contractor shall undertake the following works

Approval of design & drawing of civil structures

- Approval of developmental plans and landscaping

- Approval of design & drawing of inspection bungalow & residential quarters
- Drainage plans & designs
- Electrification of campus area
- Pipe and piping work for potable water in campus area
- Other designs / plans required for campus area development

9.3.2. **Boundary Wall and Gates**

Construction of Boundary wall (average height 1.8 meters above ground as per the conceptual drawing given in the drawing) all along the periphery of the acquired land, and providing and installation of One Main gate, along with other gates, with Cow Catcher and Gate lights, complete in all respect. The Wall, wherever necessary must be designed for protection against flow of the adjoining river/nallah/impounding tank or against steep slopes. The boundary wall shall be made in RR stone masonry in CM 1:4 and shall be plastered with 25 mm thick in CM 1:4, the base concrete of cement concrete mix 1:4:8 of minimum 150 mm shall be provided. The top of wall shall be provided with 75 mm thick RCC coping in M15. 50mm thick DPC with a base coat of hot blown bitumen layer shall be provided.

9.3.3. **General grading of Campus areas**

The ground levels of the campus areas shall be properly graded as per the landscaping plan approved. The landscaping shall be done considering the existing contour of the land and to avoid proper drainage of the campus, providing adequate leveled area for different units to be housed in the campus and to provide roads with slopes not steeper than 1:20.

9.3.4. **Horticulture and Land Scaping**

Must be done according to the topography of the area and should be planned so as to make the campus a focal point. The open areas must either be covered by tree plantation or must be suitably grassed. Shadow trees must be planted at a maximum distance of 30 m c/c along the periphery of the campus area and along the roads. The campus must be provided with gardens, with seasonal flowerbeds and decorative plants.

Horticulture operations shall be started on ground previously levelled and dressed to require formation levels and slopes. In case where unsuitable soil is met with, it shall be either removed or replaced or it shall be covered over to a thickness decided by Engineer-in-charge with good earth.

Material :

The grass shall be fresh, free from weed and rank vegetation but having Rhizomet with sufficient nodes and shall be approved by the Engineer-in-charge before planting. The manure shall be well decayed free from grits and any other unwanted materials. The good earth to be used for gardening shall be free from kankar, Moorum, building rubbish and any other foreign matter. It shall have pH value ranging between 6 to 8.5.

Trenching :

Trenching of soil in depth between 30 to 60 cm shall be done in order to loose the soil, and turn over and buried the top layer containing weeds etc. in the base and to bring up the lower layers of good earth to form proper medium for grassing, regrassing, hedging, shrubbery.

Spreading :

The good earth shall be spread evenly over the surface with twisting motion to avoid segregation to the thickness ordered by the Engineer-in-charge.

Grassing :

The area from where the grass roots are to be obtained shall be specified by the Engineer-in-charge at the time of execution of the work. The soil shall be suitable moistened and then the operation of planting grass shall be commenced. Generally planting in either direction at 15 cm, 10 cm spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawns.

Digging Holes for Planting Trees:

Holes or circular shape in ordinary soil shall be excavated to the dimensions ordered by the Engineer-in-charge and shall be manured with powered neam/caster oil cake at the specified rate alongwith farm yard manure or sludge shall be uniformly mixed with the excavated soil.

9.3.5. **Internal Roads**

The internal roads shall be made of the same specifications as those of the service road, specified in the chapter for " Specifications for Roads" of this Volume. Along the road concrete tiles pitching of approved shape and size shall be provided.

9.3.6. **Electrification**

Suitable planned electrification works are to be done for providing light flux as per provisions laid in Chapter for "Specifications for Civil Works", along the roads, all along the boundary of campus and all other important points within the gardens.

The main entrance door to campus, outside area of WTP and clear water pump house, entrance to inspection bungalow and gardens must be provided with street lights to provide at least a flux as per details given in Chapter for "Specifications for Civil Works" of this volume.

In no case, the spacing between two successful street poles must be more than 30 meters along the internal roads and boundary walls.

The specifications of poles, cabling, switches, junction box, receptables, lamps etc. used for electrical works, shall conform to the provisions laid down in Chapter for "Specifications for Civil Works" of this volume-II of bid document.

9.3.7. **Drainage System**

Suitable drains of required capacity and size shall be constructed by contractor after getting approval by the department. The approved drains must be provided all along the roads and to carry other sullage wherever required, upto the nearest natural drain.

Septic tanks of suitable size shall be constructed for the office buildings and residential quarters.

9.3.8. Construction of buildings, office,MCC and Consumer care centre etc

The plan of the proposed MCC and Consumer care centre to be constructed are shown in Drawing of the bid document. The contractor shall submit the detailed drawings with required designs showing details of fittings, sanitary and water supply pipelines, drainage arrangements and electrical drawings for the approval of Engineer-in-Charge.

The plinth of the buildings shall be kept at least 0.60 meters above the campus road level. The minimum specification of the various components of the building shall be as per Table A below

Table 'A'

TECHNICAL SPECIFICATION FOR INSPECTION BUNGALOW and RESIDENTIAL BUILDING

S. No.	Item	IB, Residence Building
1	Base concrete for foundation	1:4:8, 15cm thick
2	Masonary in foundation and plinth	RR stone masonry in CM 1:4
3	Damp proof course	1:2:4 minimum 75mm Tk with hot blown bitumen layer
4	Superstructure	Brick Masonary in CM 1:4 23cm thick/ or stone masonry 30 cm Tk
5	Lintels sun-shades etc.	R.C.C. lintels & sun shades as per approved drawing.
6	Roofing	RCC grade M-20, For roofs treatment shall be provided with brick bat coba & finishing coat of 25 mm thickness in CM 1:4 with Water Proofing Treatment
7	Interior Finish (Cement Plaster)	20mm & 25mm in cement plaster in CM 1:4
8	Exterior Finish	Cement Mortar 1:4, 20 to 25 mm thick
9	Flooring	
a	With CC 1:3:6 base	Soling Stone or with C.C. 1:3:6 base concrete if not available
b	Finish	30-40 mm thick Blue Kota Stone & mat finished tile flooring in Bathrooms & toilets.

S. No.	Item	IB, Residence Building
10	Skirting and dados	10 cm. Height of same material as used for floors & glazed ceramic tiles in toilets upto lintel level
11	Windows (frame, panels, wire gauging, safety bars)	Steel Section window as per design
12	Doors (Frames and shutter)	Frame - pressed steel section Shutters - Flush door 35 mm Wire gauge doors on all exterior door.
13	White/ Colour/Cement lime/ Decorative Finish	Oil bound Distemper on all internal walls Water proof cement paint on exterior walls.
14	Painting of doors, Windows and walls	Synthetic enamel paint with base coat of app. primer
15	Electrification (type of wiring, fittings and fixture)	Recess PVC Conduit wiring as per approved drawing and specifications. 16 A and 6 A ampere switches shall be left as per requirements, in all room and main board with MCB's, kit-kat fuses, an electric meter, earthing protections and earthing system shall be installed for each unit.
16	Sanitary & Water Supply	
	(I) Indian WC	In Common toilets
	(A) Wash Basins	In every toilet
	(iv) Sinks	White glazed vitreous china
	(v) Other accessories	As per approved drawing (of superior quality)
17	Other Specification	PVC frames & shutters in Bath rooms/Toilets
18	Special fitting and fixture	
a	Fans	In every Room
b	Tubelight, foot light	.LED ,In every Room
c	Exhaust fans of suitable sizes	Kitchen / Bathroom
d	Coolers 4000 cum/hr capacity	In every Room, dinning room.

S. No.	Item	IB, Residence Building
e	Storage type Electric geysers 25 lt capacity.	In every bathroom & instant geyser in kitchen
f	Decorative type metallic curtain rods	On every window & door
g	Toiletries (Towel rail, towel ring, looking mirror, khuti, soap dish, brush holder, tray etc.)	In all bathrooms
h	Cupboards	Covered with wooden shutters with Sun mica facing in all rooms & kitchen.

Colour, design & make of tiles & sanitary ware shall be got approved by EiC. In all toilets and kitchen direct supply as well as supply from storage tank shall be provided. Separate storage tank of 500 lt capacity for kitchen shall be provided. Storage tank shall be of Syntex, Polycon, Laxmi make. Mirror light in toilets of inspection bungalow shall be provided.

9.3.9. **Specification for Furnitures'**

9.3.9.1. **Executive Table –**

Godrej or Equivalent make table frame of 25x25 mm tubular section of 16 gauge ERW MS pipe, with standard size two drawers on right side operate on precision made slides, using 22 gauge MS sheet. Tabletop of 18mm thick particle board laminated with veneer top (shade to be approved by EIC) and back panel having teal wood beading all around. Drawers to be provided with suitable locking arrangement and with Godrej type handle.

Size – 2135 mm x 865mm - height 735mm

9.3.9.2. **Table –**

Godrej or Equivalent make table frame of 25x25 mm tubular section of 16 gauge ERW MS pipe, with standard size two drawers on right side operate on precision made slides, using 22 gauge MS sheet. Tabletop of 18mm thick particle board laminated with veneer top (shade to be approved by EIC) and back panel having teal wood beading all around. Drawers to be provided with suitable locking arrangement and with Godrej type handle. (Godrej or Equivalent)

Size- 1675mmx865mm - height- 750mm

9.3.9.3. **Revolving chairs with arms-**

Godrej or Equivalent make chair with revolving seat on tubular pipe frame of 25mm diameter ERW MS pipe of 14 gauge having high back with push back system and PU arms on five pronged base with ball coaster and pneumatic seat height adjustment. Moulded PU foam on seat and back and covered with good quality tapestry, Colour& quality of tapestry shoed be used as approved by EIC.

Size-66Cm(d)x66Cm(w)

Height - 102.5Cm-114.5Cm

Seat height – 44Cm-56Cm

9.3.9.4. **Visitor chair –**

Godrej or Equivalent make chair made of 25mmx25mm tubular section of 14 gauge, 25mm diameter ERW MS pipe of Moulded PU foam on seat & back with upholstered seat and back by good quality tapestry as approved by EIC.

Size-46Cm(w)x82Cm(h)

Seat height – 45 Cm

9.3.9.5. **Steel Almirah –**

Godrej or Equivalent make office storewell made from high quality CRCA steel of 20 gauge having anti rust treatment equipped with Godrej precision lock and four adjustable shelves with powder coated finish of following sizes:

1980mmx915mmx485mm (Big)

1270mmx765mmx440mm (Small)

9.3.9.6. **Filing cabinet –**

Godrej or Equivalent make 4 drawer lateral filing cabinet made of premium quality CRCA corrosion resistant steel of 20 gauge with 25mm teak wood table top and powder coated finish. Drawer should be moved on precession balls slides with anti tipping and anti-rebound mechanism provided with full length drawer pulls.

9.3.9.7. **Desert cooler –**

600mm sweep ISI mark exhaust fan and ISI mark water pump fitted in 20 gauge MS body.

Godrej precision lock, handle and label holder.

9.3.9.8. **Ordinary cane chair -**

Godrej or Equivalent make made of 25mm diameter tubular MS ERW pipe of 14 gauge seasoned teak wood seat and back with canning without arms, cantilevered chair duly polished and painted and using half round canning.

43cm(w) x 57cm(d) x 88.5cm(h)

45cm seat height

9.3.9.9. **Side racks –**

Godrej or Equivalent make made of 35x35x5mm ERW MS angle section with five shelves. Shelves material should be 20 gauge ERW MS sheet.

5 tier - 1800mmx900mmx375mm

Chief Executive Officer
Udaipur Smart City Limited

Chapter 10. Specifications for Water Meters

10.1. General

Under this contract, it is proposed to replace the non functional water meters, install new water meter for all existing non metered water connections and new connections to be released during the contract period (Including O&M period) and Maintenance of all installed equipments for ten years icluding one year defect liability period. The objective of the works proposed in this contract is to assess water distributed correctly and to recover the cost of water on the basis of actual consumption by the each consumer. The contractor shall carryout all works wholly in accordance with the terms and conditions of the contract to fulfill the requirement of the work. All the material used, and the equipment installed shall be as per the specifications defined in the contract and the work shall be executed with goodengineering practices.

10.2. Water Meters (Consumer)

10.2.1. Scope

This includes water meters

I. Standard Multi-jet, Class -B magnetically coupled water meter in horizontal position with super dry "dial and hermitically sealed conforming to IS 779-11994 (ISI Marked)or ISO 4064 with latest specifications with EEC/MID mark, along with (IP 68 protection with metallic can register) Meter with nut and nipple set. Warranty ten years, Endurance test conducted by FCRI.

I. AMR Multi-jet, Class-B magnetically coupled / Ultrasonic AMR water meter in horizontal position with super dry " dial and hermitically sealed conforming to IS 779-11994 (ISI Marked) or ISO 4064 with latest specifications with EEC/MID mark,

along with (IP 68 protection with metallic can register) Meter with nut and nipple set. Warranty ten years, Endurance test conducted by ECRI.

10.2.2. **REFERENCES**

Indian Standards 779: 1994 (Reaffirmed 2004)/ ISO 4064 .

10.2.3. **MATERIALS**

Water meter shall be made of materials of adequate strength and stability for the purpose for which the water meter is to be used. It must be constructed with materials which are resistant to internal and normal external corrosion and if necessary be protected by some suitable surface treatment. Parts coming in contact with water shall be made of materials resistant to corrosion and shall be nontoxic and non staining. Use of dissimilar metals in contact under water should be avoided as far as possible in order to minimize electrolytic corrosion. Water temperature variation within the temperature range specified must not adversely affect the materials used in the construction of the water meter.

10.2.4. **CONSTRUCTION**

10.2.4.1. **General**

The meters shall be constructed in such a way as to:

a. give long service and guarantee against any fraud or tempering and
b. conform with the provisions of Indian Standards, 779-1994 under normal conditions of use.

Where meters may be subjected to an accidental reversal of flow, they must be capable of withstanding it without any deterioration or change of their metrological properties, and at the same time, shall record such a reversal.

10.2.4.2. **Body**

The body shall be free from all manufacturing and processing defects, such as blow-holes and spongy structure and shall not be repaired by plugging, welding or by the addition of materials. The internal shape of the body shall ensure smooth flow of water and easy dismantling.

10.2.4.3. **Registration Box & Cap**

a) Registration Box: The Registration box of dry-dial water meters may be provided with escape hole(s) for minimizing the accumulation of water. Where the registration box and cap are integral with the body, no escape hole shall be provided.

b) Cap: The material for cap shall be the same as used for registration box. The cap shall be so designed and fixed to the registration box to avoid entry of water and dirt. The transparent window which covers the digital portion shall be inserted from the inside into the cap. The protective lid shall be secured by a robust hinge or other suitable method

of construction. Cap ring where applicable should be of the same material as of the cap.

c) The transparent window glass should be thick enough and shock registrant. It may be oftransparent Acrylic, Window glass shall be coated with automist fluid.

10.2.4.4. **Connections**

The meter casing shall be fitted in the pipe line by means of two cylindrical nipples or tailpieces with connecting nuts which shall be provided with each meter. The threads on theconnection shall conform to IS 2643 (part 1 to 3): 1975.

10.2.4.5. **Strainers**

Water meter shall be provided with strainers. They shall be rigid, easy to remove ,clean andshall be fitted on the inlet side of the water meter. It shall be possible to remove and cleanthe strainer in such a way as not to disturb the registration box or tempering with it. Thestrainer shall have a total area of holes not less than twice the area of the nominal inlet boreof the pipe to which the meter is connected. The free area of holes shall be such that itcomplies with the head loss at nominal and maximum flow rate. However in the case ofmeters provided with internal strainer involving opening of the registration box for cleaning,an additional external strainer shall be fitted on the inlet side satisfying the aboverequirements.

10.2.4.6. **Impeller**

Impeller and impeller shaft assembly shall rest on a self-lubricating bearing which has a lowfrictional resistance as possible.

10.2.4.7. **Impeller chamber and measuring chamber**

The impeller chamber and measuring chamber shall be rigid and shall not change its form asa result of internal stress or with use.

10.2.4.8. **Gears and Pinions**

The gears coming in contact with water shall be of non-magnetic, stainless steel andthickness not less than 1.66 mm this shall be so constructed as to fully and smoothly messwith each other and shall be firmly fitted on there shaft. All other gear and there spindlesshall be of brass or nickel plated brass. The brass gears shall be made from plates not lessthan 2 mm thick. All other parts shall confirm to IS 779-2004.

10.2.4.9. **Bearing**

Impeller bearing shall be suitably grounded and polished. The shape of the impeller bearing shall be such as to prevent the penetration of particles of sand and to preclude the deposit of anything in solution or suspension in water and to facilitate the washing away of such deposits by the water flow. The shaft of the gears shall revolve freely in

these bearings. The length of the bearing shall ensure their effective operation. All bearing and supporting plates shall be of Sapphire (Synthetic). The bearing plates shall be of sufficient thickness to prevent distortion during assembly and tests.

10.2.4.10. **Counter**

The counter shall be of the straight reading cyclometer type. The roller of the cyclometer counter shall be made of plastics (ABS/Acetol co-polymer) specially suitable for the purpose and shall be self-lubricating. Those counters shall be arranged on single shaft with interlocking arrangements in such a devise, not allowing any rotation to these counters if pressure is applied by the object inserting from out side through damaged windows for changing meter reading. The pointer shall be of brass or plastic and shall be soldered to the spindle.

10.2.4.11. **Regulator**

Every inferential meter shall be provided either with external/ internal regulator. The external regulator shall be accessible from outside to be operated by the suitable key without dismantling the meter and not without breaking the seal. The internal regulating device shall not be accessible from outside.

10.2.4.12. **Sealing**

Sealing holes shall be provided and the meter shall be sealed in such a manner as to render it impossible to obtain access to the measuring unit including registration box and cap without breaking the seals. The sealing wires shall be made of rust proof material.

10.2.4.13. **Screws and Nuts**

Screws, studs and nuts shall be of brass. Where fasteners are likely to come in contract with water they shall be made of brass as per IS: 320-1980 or stainless steel having not less than 10% chromium and 8% nickel contents.

10.2.5. **INDICATING DEVICE**

Indicating device shall be able to record 9999 kl (min) for meter size of 15, 20 and 25mm and 99999 kl (min) for size 40 and 50mm and shall thereafter indicate zero.

The indicator shall allow by simple juxtaposition of its various constituent elements, a reliable, easy and unambiguous reading of the volume of water measured, expressed in liters. The volume is indicated of the row of in-line consecutive digits in one or more apertures.

The kilo-liters and its multiples shall be indicated in black and sub-multiples of the kilo-liters in red. The colour coding applies to the drum in in-line digit indicating device. The actual or apparent height of the digits on the drum shall not be less than 4mm. The digits from 0 to 9 shall be embossed on the circumference of each counter.

For digital indicators, the visible displacement of all digits shall be upward in value. The advance of any given digital unit shall be completed while the digit of the immediately

next lower value describes the last tenth of its travel. The drum showing the digits of the lowest value may move continuously. The whole number of kilo-liters shall be clearly indicated.

10.2.5.1. **Value of verification scale division**

Verification scale interval for class 'B' meters will be as given in Table-1 of IS: 779-1994 (amended up to date).

10.2.6. **METER SIZE AND OVERALL DIMENSIONS**

Meter size and overall dimension should be as per clause No. 9 of IS 779:1994(amended upto date)

10.2.7. **TECHNICAL CHARACTERISTICS**

The technical characteristics should be as per clause no. 10 of IS: 779-1994 (amended up todate).

10.2.8. **PRESSURE TIGHTNESS**

A meter shall be able to withstand the continuous water pressure of (i) 1.6 MPa for 15minutes, and (ii) 2 MPa for 1 minute, when tested in accordance with IS: 6784-1995(amended up to date)constantly without defects in its functioning, leakage, seepage through the walls orpermanent deformation.

10.2.9. **LOSS OF PRESSURE**

Loss of pressure through the meter when determined in accordance with IS: 6784-1995 shallnot exceed 0.025 MPa at the nominal flow rate 'Qn' and 0.1 MPa at the maximum flow rate,'Q max'.

Note: Nominal flow rate Qn shall be taken as per Table-2 and maximum flow rate Qmax astwice the nominal flow rate.

10.2.10. **TEMPERATURE SUITABILITY**

The test shall be carried out in accordance with IS: 6784-1996.

10.2.11. **METROLOGICAL CHARACTERISTICS**

10.2.11.1. **Metering Accuracy**

The maximum permissible error in the metering accuracy when determining as per IS: 6784-1995 shall be as under:

a) In the lower region of flow Qmin (inclusive) to Qt (exclusive) 5%
b) In the upper region of flow Qt (inclusive) to Qmax (inclusive) 2%

Note: value of Qmin, Qt and Qmax for the three classes of water meters are given in Table-3

10.2.11.2. **Minimum Starting Flow**

The minimum flow at which the meter starts registering shall be as given in Table 3 of IS:779-1994 (amended up to date) for the class 'B' of water meters. The test shall be carriedout in accordance with IS: 6784-1995.

10.2.12. **TESTS**

10.2.12.1. **Acceptance tests**

The production routines are to be repeated at the time of purchase. These tests shall becarried out at the manufacturer's works. All the arrangements for the test are to be providedby the contractor.

10.2.12.2. **Production Routine Tests**

Production routine tests shall consist of:

a) Pressure tightness
b) Loss of pressure
c) Metering accuracy
d) Minimum starting flow

10.2.12.3. **Type Test**

a) Life Test (Endurance Test)

The above tests and any other test if included later on shall be carried out as per IS: 779-1994 and other relevant Indian Standards/ ISO standard.

10.2.13. **MARKING**

Each water meter shall be marked/ embossed with the following information

a) Manufacturer's name or trade mark.
b) Nominal size and class of water meter.
c) Direction of flow of water on both sides of the body of water meter.
d) Year of manufacture and serial number.
e) BIS/ISO Certification marking.
f) USCL - PHED

10.3. **In addition to above following specification shall also be complied by the bidder**

10.3.1. **Specifications for AMR multi-jet magnetically coupled Water Meter**

	Indicating device Digital type: minimum 4 digits for Kl
1.	External regulator with sealing arrangement
2.	Reading unit Kilolitre
3.	The water meter dial super dry hermetically sealed for clear reading in all seasons
4.	The water meter shall be hydrostatically & hydro dynamically balanced so as to give long service.
5.	Strength of Coupling magnet Preferably of hard ferrite type shall withstand against 100° C and it shall not reduce more than 1 % during the life span of 15 years.
6.	Suitable for ambient temperature 45° C.
7.	The meter shall be suitable to the water available without affecting its performance & life.
8.	Water meter shall be provided with Brass nipple and coupling nut.
9.	The serial no. and year of manufacture of the water meter shall be embossed or punched on body and at one more place other than the body.
10.	The water meters shall be painted with two coats of light blue colour.
11.	Water meter shall be shielded from external magnetic field.
12.	The installation of water meter shall be carried out as per site engineer's instructions.
13.	The supplier/ manufacturer shall have his own recognized meter test laboratory along with service facility in operating condition at least for last 5 years.
14.	The test certificates from Govt. / Semi Government – institutions for material of construction of water meters shall be produced by the contractor at time of inspection.
15.	The supplier shall submit detailed drawings of all meter supplied size wise with necessary installation, maintenance and operation manuals.

10.4. **Technical Specifications for AMR Ultrasonic Water Meter**

1. A battery operated inline Ultrasonic water meter with no moving parts.
2. Battery operated meter with a battery life of minimum 10 years. The life of battery of AMR water meter shall not be less than 10 years from successful installation of said AMR water meter along with its AMR system.
3. Meter must comply to IP68 for indoor and outdoor operation, including fully submerged installations.
4. The meter should be type approved and verified according to international water meter Standard OIML R 49 and or ISO 4064. The meter should be MID approved.

5. Accuracy Class 2 – +/-2% or better over typical operating range and temperatures. The Ultrasonic water meter should maintain its accuracy over its lifetime.
6. 3-Point calibration with calibration certificate available for each unit.
7. Dynamic Range (Q3/Q1) of Minimum of 100:1.
8. The water meter body shall be made of corrosion resistant material like brass, bronze, stainless steel, carbon steel or Engineered plastic.
9. Working pressure of ≤ 16 bars.
10. Environmental Temperature of 0 degree C to 50 degree C
11. The meter should be tamper proof with suitable data protection of calibration and revenue parameters.
12. The smart meter should have advanced diagnostics with active alarm(s) indicated on display.
13. Display with ≥8 digits for main information. Index, menu and status symbols for dedicated information.
14. The measuring units should be m^3 for volume.
15. The Ultrasonic water meter should have inbuilt remote reading capability using point-to-point RF or any other data collection technology.
16. Tampering, Burst, Leakage etc.
17. The water meters shall have the anti – magnetic properties / immunity, as specified in ISO-4064:2005, when tested with 4000 gauss magnet. The AMR system shall remain unaffected with application of 4000 gauss magnet, as specified in ISO-4064:2005.
18. If manufacturer has an ISO 17025 accredited calibration lab, then their calibration certificate should be acceptable and separate TPI (Third Party Inspection) / calibration for Govt. approved laboratories not required and should be waived off.
19. Warranty ten years, Endurance test conducted by FCRI.

Annexure-B

Materials for Body and Component parts of Water Meter

Sl No	Body/Component Part of Water Meter	Materials	Ref to IS
1	Body	Brass	Grade DCB2 of IS: 1264-1989
2	Registration box	Brass/ Copper	Grade DCB2 of IS: 1264-1989
3	a) Cap	Brass/ Plastic	Grade DCB2 of IS: 1264-1989
	b) Cap ring	Brass/ Plastic	Grade DCB2 of IS: 1264-1989
	c) Cover	Brass/ Plastic	Grade DCB2 of IS: 1264-1989
4	Screws and studs	a) High tensile brass	IS: 320-1980
		b) Stainless steel	Designation 07 Cr. 18 Ni9 of IS: 6911-1992
5	Strainers	Plastics	HDPE (see IS: 7328-1992)
6	Impellers	Plastics	ABS

Sl No	Body/Component Part of Water Meter	Materials	Ref to IS
7	Impeller shaft	Stainless steel	Designation 07 Cr 18 Ni 9 of IS: 6603-1972
8	Nipples and nuts	Brass	Grade DCB2 of IS:1264-1989
9	Gears gearshaft and pinions	a) for use under water	
		Stainless steel (Note: Stainless steel shaft should preferably be used with plastic gears/pinions)	Designation 07 Cr 18 Ni 9 of IS: 6603-1972
		b) for use above water	
		1. Brass Rod	Grade 1 half hard of IS: 319 - 1989
		2. Brass sheet (for gears only	Grade CuZnPh2, half hard of IS: 531-1981
		3. Plastics	ABS
10	Bearings	Agate/ Sapphire (Synthetic)/Graphite filled Nylon/ Sintered Bearing	
11	Counter	Plastics	ABS/ Acetal co-polymer
12	Dial	a) Copper duly enameled or powder coated	
		b) Plastics	High impact polystyrene confirming to IS2267:1995/Acrylic/ Acetal co-polymer

10.5. CONNECTION TO CONSUMERS:

I. All service pipes and fittings from the connection on the water main to any premisesshall be laid by the Contractor as per specifications and the approved drawings Theconnection pipe shall be laid in the ground and shall not be less than 45 cm belowthe surface unless laid inside a building. All pipes shall be laid or fixed in such amanner as not to be exposed to the heat and not to cause any damage to anyconsumer's pipes and fitting and there should not be any risk of mixing waste wateror cause contamination of water. The material of the pipes and fittings shall be gotapproved from the Engineer-in-charge before use. The position of the stopcock onthe connection pipe shall be decided by the Contractor. All cocks and taps fitted tothe service pipes in any premises shall be of a screw down pattern and of qualityapproved.

II. No pipe used for the conveyance of water shall be laid or fixed which shall runthrough any drain or any place where water through such pipes is liable to becomepolluted or contaminated or where the pipe is likely to get damaged. However, inunavoidable cases such consumer's pipe may pass through an exterior air tight andwater tight pipe or jacket of cost iron or other material approved by the ExecutiveEngineer of sufficient length and strength and of such construction as would provideadequate protection to the inner pipes. The cost of which is to be borne by theConsumer.

III. Every premises supplied with water shall have its own specific connection pipe andno connection pipe shall be used to supply water to more than one premises.

IV. The position of stop cock on the connection pipe shall be decided by the Contractorwho shall have exclusive control over this stop cock and its operation.

V. For connections of sizes 25 mm and above, the stop cock will be fitted with a crutchof spindle head of specific design to suit a key or wheel kept by the Contractor.

VI. The leakages upto the stop cock or up to the meter without stopcock shall beremoved by contractor at his cost.

10.6. COMPOSITE STRAP SADDLE

10.6.1. SCOPE:

The specification covers the requirements for manufacturing, supplying testing at works ofComposite Strap Saddle used for tapping water supply connection from D.I. pipe /HDPE/AC distributionline.

10.6.2. STANDARDS

Pipe compatibility: D.I. K – 7 pipe as per ISO: 2531, EN: 545, EN: 598, IS: 1239-1, IS: 3589.Comply with ISO: 4427 Part – 3 & EN: 12201 – Part -3

10.6.3. SPECIFICATION

10.6.3.1. GENERAL SPECIFICATIONS:

- Clamp saddles for service connection from water distribution mains shall be ofwrap around design, wide skirt and wide straps support, which shall reinforce thepipe while providing excellent stability to the saddle. Clamp Saddles for serviceconnections shall be of fastened strap type with threaded outlet for serviceconnection.
- The service connection threading sizes shall be conforming to IS: 554
- Clamp saddles shall be suitable for DI/GI/uPVC/HDPE pipes of nominal sizes
- The straps shall be elastomer coated (insulated) type for firm grip on pipe as wellas to protect the coating on the pipe and to insulate the un-identical metals.

Thesaddles shall be single strap type up to pipe sizes of NB 600 and service outlet of½", ¾" and 1".

- The saddles shall be double strap type for pipe sizes above NB 600 or when theservice outlet is 1 ¼", 1 ½" or 2".
- Fasteners shall be of threaded nut-bolt-washer type. Nut-bolts of size ½" (M12)shall be used for saddles of size up to 4" (NB 100) and Nut-bolts of size 5/8" (M16)shall be used for saddles of size 6" (NB 150) and above.
- The sealing between the saddle and mains shall be obtained by using a profiledelastomer seal matching to the curvature of the pipe. The seal shall be ofelastomer type, suitable for all potable water applications.
- The Material of construction of the body shall be of a non-corrosive material suchas engineering plastic (PE/PP) or stainless steel or a combination of both.
- The design of the saddle body should be such that, the service connection outletmetal insert shall project out towards pipe side and align with the hole drilled onthe pipe to ensure positive locking against rocking or creeping on the pipe, asmight be caused by vibration, pressure or excessive external loading.
- The clamp saddles shall be suitable for maximum working pressures up to 10bars.

10.6.4. **MATERIAL AND DESIGN SPECIFICATIONS**

10.6.4.1. **SADDLE BODY**

Non-corrosive Engineering Plastic (PP / PE) body moulded with Stainless steel threadedmetal insert for tapping outlet. Also, the stirrup metal plate shall be duly embedded in theplastic body, except at the place of nut-bolt lugs. Threading size and dimensions shallconform to IS: 554. The body shall have retaining cavity housing for internal and externalretention of the elasomeric seal. Sealing shall be achieved by pressure exerted by the bodywhile fastening the saddle straps & body on the pipe.

10.6.4.2. **SADDLE STRAP:**

Saddle straps shall be made of stainless steel 304 grade to prevent corrosion over the longservice life.

10.6.4.3. **STRAP INSULATION**

Elasomeric (rubber) insulation / lining shall be such that none of the Stainless Steel Strap isin direct contact with the pipe. It shall ensure a firm non slip grip mounting on the pipe toprevent the saddle from rocking or creeping on the pipe, as might be caused by vibration,pressure or excessive external loading.

10.6.4.4. **SADDLE SEAL**

It shall be virgin rubber SBR Grade 30 / NBR (NSF 61 approved). It shall be of type pressureactivated hydro-mechanical design. It shall be contoured gasket to provide a positive initialseal, which increases with increase in the line pressure. Gasket shall be

gridded mat, withtapered ends, with the outlet section having o-ring contacting the saddle body multiple oringscontacting the pipe, preferably with a Stainless steel reinforcing ring insert moulded toprevent expansion under pressure.

10.6.4.5. **NUTS-BOLTS- WASHER**

Stainless Steel Type 304, NC rolled thread, Tightening torque for ½" (M12) nut-bolt: 14 – 15kg.m and for 5/8" (M 16) nut-bolt: 21-23 kg.m

10.7. MAKING HOUSE SERVICE CONNECTIONS

One Service connection means one tapping from a distribution main / sub- main includingone tapping saddles, elbows, and service pipe from tapping point to the chamber nearproperty boundary or inside the property as per the direction with U-ball valve.

Providing required size of HSC brass ferrule with union confirming to relevant IS make holeby drilling on top of distribution mains, fixing the ferrule making the connection water tightetc., as shown in the drawing and as directed by the Engineer including cost of requiredspecials. Drilling charger, hydraulic testing, maintaining the same for the period under O&M.

10.7.1. MATERIAL

Medium Density Polyethylene pipe (MDPE) below ground level and GI pipe above Ground levelshall be used for house service property connection.

10.8. In addition to above following specification shall also be complied by the bidder

1.	Indicating device		Digital type: minimum 4 digits for Kl
2.	External regulator		with sealing arrangement
	Reading unit		Kilolitre
	The water meter dial		super dry hermetically sealed for clear reading in all seasons
	The water meter shall be hydrostatically & hydro dynamically balanced so as to give long service.		
	Strength of Coupling magnet		Preferably of hard ferrite type shall withstand against 100° C and it shall not reduce more than 1 % during the life span of 100 years.

	Suitable for ambient temperature		45° C.
	The meter shall be suitable to the water having parameters given in annexure 'A' without affecting its performance & life.		
	Water meter shall be provided with Brass nipple and coupling nut.		
	The serial no. and year of manufacture of the water meter shall be embossed or punched on body and at one more place other than the body.		
	The water meters shall be painted with two coats of light blue colour.		
	Water meter shall be shielded from external magnetic field.		
	The job of supplying and installation shall include all necessary work to fix the meters on site such as excavation, cutting, removing existing meter and refitting new one on the consumers' connection with necessary fittings as the case may be and including modification required in layout at site as per requirement.		
	The job includes cost of material and labour both.		
	The installation of water meter shall be carried out as per site engineer's instructions.		
	The contractor shall establish his own testing facility with all its components duly calibrated from authorised agency.		
	The literature, leaflets giving technical details of the meter and true copies of documents in respect of ISO process, validation and pattern approval shall be submitted along with bid document.		
	The third party inspection shall be carried out by FCRI. Sample size and criteria for acceptance of meter to be tested by FCRI shall be as per table 4 of IS : 779 : 1994 (amended up-to-date).		
	The supplier shall submit detailed drawings of all meter supplied size wise with necessary installation, maintenance and operation manuals.		
	Two technicians of PHED shall be trained for period of two weeks at the workshop of the manufacturer to carry out repair work etc.		
	The meters reported out of order within the contract period shall be replaced from the site within 3 days from receipt of written intimation from PHED, Failure to comply this will be liable for penalty of Rs. 50/- per day per meter. Subject to maximum of Rs. 500/-Transportation & other charges shall be borne by the contractor. The meter so repaired will have accuracy as per BIS/ISO/EEC/MID which shall be witnessed by PHED representative.		

The bidder shall submit 20 nos. samples of model of water meters offered before opening of pre-qualification bid. Out of these any 5 samples shall be selected randomly and the department shall send these samples duly sealed to FCRI for Type Test including Life

Cycle Test (as per IS 779-1994, clause 12.4) Remaining 15 no's will be returned to bidder. The cost of these tests along with incidental charges will be borne by the bidder.

10.9. Installation of Meters:

1. The contractor will store and ensure safety of the meters supplied in a store under the joint custody of the Contractor and the Engineer.
2. The meters will be installed in the stipulated areas and on premises as directed by the Engineer.
3. The Engineer will provide a list of connection giving owners name, address, Service connection Number, size of meter, etc. in a standard format.
4. The contractor will be responsible to maintain adequate stock of the required water meter with Orifice Flow Equalizer, meter box and trained work man crews to ensure smooth completion of the jobs professionally and in time.
5. The contractor will be responsible to return the water meter removed from the site either to the consumer and obtain receipt or to the PHED along with a statement of the meters removed in a stipulated format as directed by the Engineer.
6. The contractor will also have to obtain and deposit the meter installation report in the format stipulated by the PHED duly signed by the owner of the connection..
7. All statements required to be submitted in this contract shall be submitted to the Engineer/PHED weekly.

10.10. Repair and Maintenance of meters during the Guarantee and the Maintenance period:

1. The PHED will periodically provide the contractor a list of the meters reported out of order.
2. Any fitting or pipe piece required to be replaced to make the fitting satisfactory for the replaced meter will have to be provided by the contractor at his cost. Transportation & other charges shall also be borne by the contractor.
3. If the meter seal is found to be broken/meter is damaged, the matter shall be reported to PHED with acknowledgement & with their consent meter shall be rectified/ replaced by contractor. The cost of rectification/replacement in such cases shall be charged from consumer as per prevailing rates by the department.

4. All the material / spares required for rectification of defective meters during Maintenance shall be supplied by the contractor free of charge including testing & calibration of the meter.
5. The rate quoted shall include removing the meter, cost of spares, labour charges, calibrations charges, testing, transport, & Reinstallation etc.
6. In the case of theft of the water meter the matter shall be reported to the nearest police station & PHED by the consumer and the connection with water meter shall be restored by the contractor within 3 days from the date of intimation by PHED.
7. The contractor shall submit monthly report to PHED giving Sr. No. wise status of the meter, make, type, size, date of installation, its location, whether repaired, with remarks if any & separate monthly report on performance of defective meters in the stipulated format.
8. The contractor shall codify all the meters newly installed so as to identify them easily.
9. A quarterly report giving no. of failed meters along with their locations and remedial action taken by the contractor shall be submitted.
10. The contractor shall maintain a history card / register for each meter (including replaced, existing) & subsequently installed and update the same whenever the water meter is repaired/ calibrated.
11. Complaints regarding meter running fast or slow will also be treated as defective meter. The contractor shall rectify / replace the meter with good one, if complaint is found genuine.
12. The contractor will prepare a comprehensive report on the performance of meters annually in a format satisfactory to the Engineer/PHED to give a clear picture of the repairs requirement and status of metering during the year to enable analysis of the performance of meters and it's various parts and failures.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 11. Specifications for Instrumentation

11.1. General

This section of specifications defines the general requirement of Instrumentation system to be installed for the contract. For selection of field instruments and control system or anything related to instrumentation, the Contractor shall follow the specifications contained here in.

Irrespective of the detailed specifications of the respective items detailed in the chapters of pumping stations, the contractor shall be required to provide all equipment, accessories, cabling, earthing and shall provide necessary transducers/sensors, system to achieve the requirements of the tender.

11.2. Design Requirements of Information & Control System

11.2.1. General

- Electronic instruments shall utilise solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.
- For transmitting instruments, output signal shall be 4-20 mA DC linear having two wire system.
- Unless otherwise stated, overall accuracy of all measurement systems shall be ±1% of measured value, and repeatability shall be ±0.5%.
- After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.
- The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.
- The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.5 m above grade platform.
- Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65.
- The instruments shall be designed to work at extremes of the ambient conditions of temperature, humidity, and chlorine contamination that may prevail. The instruments shall be given enough protection against corrosion.
- Lockable enclosure shall be provided for the field mounted instruments wherever required.
- All field instruments, and cabinets/panel-mounted instruments shall have tag plates/name plates permanently attached to them.

- The performance of all instruments shall be unaffected for the ±10% variation in supply voltage and ±5% variation in frequency simultaneously.
- All wetted parts of sensors shall be made out of non corrosive material capable of working with chlorine content of 5 ppm.
- For all instruments (transmitting analogue signals) installed in the field (outside pump house), lightning protection units (LPU) shall be provided at both ends of the connecting cable for the protection against static discharges/lightning and electromagnetic interference.
- Unless otherwise specified, double compression glands shall be used for glanding the cable in field instruments and instrument control panel.
- Pressure transmitters shall be provided with two valve manifold and a test port, so that in site calibration can be carried out.
- Two wire transmitters shall be provided with on-line test terminals.

11.3. **Instrument Control Panel (I.C.P.) / Control Desk**

11.3.1. **General**

Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 2 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. The control panel shall have dimensions as per system requirement. However, the control panel height shall not exceed 2000 mm.

The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.

Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.

Control Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS:13947 Part-I

Control Panel shall be free standing type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

Metal sills in the form of metal channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting the control panels. These shall be despatched in advance so that they may be installed and leveled when concrete foundations are poured.

Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Control panels shall be provided with louvers along with washable micron filters AIRIN – AIROUT fans will be provided.

11.3.2. **Mounting**

All equipments on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.

Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

11.3.3. **Earthing for Instruments**

The panel shall be equipped with an earth bus securely fixed along the inside base of panel.

All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.

A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit.

11.3.4. **Frame Earthing**

All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25 mm x 3 mm. A 15 mm diameter hole is to be provided at each end of the bar. Connection of the earth bar to the station earth shall be carried out by Contractor.

11.3.5. **Space Heater**

Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 V AC. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

11.3.6. **Interior Lighting and Receptacles**

Each panel shall be provided with a CFL lighting fixture rated for 11 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.

Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 amps and 15 amps, 3 pin receptacle with a switch and neon indicating. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

11.3.7. **Voltage Level and Power Supply Units**

Generally, voltage levels for control schemes and power supply for instruments in the panels, shall be limited to 24 V DC. In case the instruments require power supply other than 24 V DC, Contractor shall provide necessary transformers, converters, inverters and other associated hardware required to generate the requisite power supply. The power supply distribution board for panel mounted and field mounted instruments shall be provided. Power supply to all the instruments mounted outside the control panel shall be provided from the power supply units in the control panel. The power supply to all the instruments shall be without interruption and shall be continued even in case of failure of 230 V A.C. power supply. UPS sizing should take this into consideration.

11.3.8. **Labels**

All the equipment mounted on the front face of control panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

11.3.9. **Switches and Miniature Circuit Breakers (MCBs)**

Each control panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs. All such MCBs will be provided with an auxiliary contact to be used for providing MCB tripped alarm.

11.3.10. **Intra-panel (Panel Internal) Wiring**

Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 660 volt grade, stranded copper conductor insulated with PVC and designed for a minimum conductor temperature of 90 degrees centigrade. The wires shall be shielded, where necessary.

Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Department and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks.

Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.

Wire termination shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit of breaker or device, shall be distinguished by the addition of a red coloured unlettered ferrule.

11.3.11. **Terminal Blocks**

Terminal blocks for power connection shall be 660V grade, 20 amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts and identification markings. Terminal block design shall include a white fibre marking strip with clear plastic, hinged terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type and all other input signal terminals will be clip on shrouded type.

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

There shall be a minimum clearance of 250 mm between the first row of terminal blocks and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum 250 mm.

Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.

If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker or positive and negative wires, these wires shall not be terminated on adjacent terminal blocks.

11.3.12. **Cable Supports**

All external cables shall present a neat appearance and shall be suitably braced, placed in troughing clipped or laced to prevent effects of vibration.

11.3.13. **Terminal/Identification**

Every terminal and test plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

Painting of Control Panel/ Control Desk

All sheet steel work shall be phosphated in accordance with the following procedure :

i. The pre treatment shall be hot process with running water for rinsing.
ii. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

iii. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.

iv. The control panel shall be powder coated. Thickness of coating of minimum 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder coating.

11.4. Specifications of equipment/system

11.4.1. General criteria

The design /selection criteria to be applied to instrumentation systems shall be as follows:

a. all instruments shall be suitable for continuous operation
b. all transmitting instruments shall have a 4 - 20 mA linear output
c. all digital outputs shall be volt free
d. all instruments shall be designed for the ambient conditions of temperature and humidity
e. all wetted parts of instruments sensors shall be non-corrosive and suitable for use with potable water containing residual chlorine
f. all instrumentation systems for use out door shall be protected to IP 65
g. all analogue displays shall be of the digital type with no moving parts
h. instrumentation shall utilise solid state electronic microprocessor technology and avoid the use where practical of any moving parts
i. instruments shall resume operation automatically on application of power following a power failure

11.5. Flow Measuring System

11.5.1. General

Flow measuring system shall consist of flow sensor/ transducers, flow integrator & flow transmitter, digital flow indicator & integrator and any other item required to complete the system.

Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation on underground /above ground pipe lines. Full bore type/removal of flow sensors shall be possible when pipe lines are pressurised and should be leak proof at 1.5 times the working pressure at that location. This is not applicable to electromagnetic full bore flow meter.

To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided, as required by the flow meter manufacturer.

Contractor shall finalize the exact location of flow transducers in consultation with Engineer-in-Charge.

The flow transmitter shall be suitable for field mounting and shall accept input from the flow transducer. It shall process the input signal and provide 4-20 mA DC output proportional to flow rate. Flow transmitters shall have LCD display to indicate instantaneous flow rate. The flow range shall be adjustable. The flow meters shall be suitable for measuring flow at velocities of water from 0 to 4 m/sec.

Contractor shall construct a suitable concrete chamber for enclosing flow transducer to be mounted on underground pipe lines. A concrete cabin shall be constructed above the chamber for housing the flow transmitter. A concrete cabin shall be constructed for housing the flow transducer and the flow transmitter to be mounted on surface pipelines.

The Full bore type/Retraction assembly, head of the flow transducers shall be made of anti corrosive material.

The flow computer shall be microprocessor based and shall have self diagnosis facilities.

11.6. **Electromagnetic full bore type flow meter.**

If not provided with the flow meter, the flow indicator and integrator shall be provided.

S.No.	Details	Parameter
1	Principal of working	Faradays law of electromagnetic induction
2	Type	Full Bore Type with integral flow transmitter
3	Size	As per requirements.
4	Signal out put	4-20 mA DC HART, MODBUS RS-485, one scalable pulse output, one status output
5	Time contact	1 second to 20 second adjustable
6	Maximum load resistance	500 Ohm
7	Local display	Large backlit LCD to display parameters such as actual flow rate, forward, reverse, sum totalizer, velocity (m/s) as a minimum
8	Ingress Protection	IP 68 for tube
9	Flow velocity	-12m/sec to +12m/sec
10	Accuracy	0.5 % of measured value
11	Repeatability	+ or – 0.15%
12	Power supply	Normal 240 Volt AC + or – 15 % 50 Hz
13	Media pressure	As per requirement
14	Power consumption	Maximum 20 W

S.No.	Details	Parameter
15	Materials	
a)	Liner	Hard Rubber
b)	Pipe	SS316
c)	Flanges	CS PN 10
d)	Coil housing	Fully welded SS304
e)	Transmitter	Cast Aluminum epoxy painted

Note: Digital flow indicator and flow integrator shall be a combined unit

11.7. **Flow Indicator and Integrator**

	Type	:	Microprocessor based
	Display	:	Digital, seven segment back lit LCD/LED display
	Digit Height	:	14 mm or Higher
	No. of Digits for Flow indicator Flow integrator	 : :	 5 Digits 6 Digits
	Input	:	4-20 mA DC (Isolated) from flow transmitter through analogue signal multiplier
	Zero and span adjustment	:	Required
	Manual Reset Facility for flow integrator	:	Required (shall be key operated)
	Engineering units for		
	Flow rate indicator Flow integrator	: :	Cum/hr Ml
	Battery backup for integrator	:	Required

Note: Digital flow indicator and flow integrator shall be a combined unit

11.8. **ULTRASONIC FLOW METERS**

The supplied flow meter must comply with the national/international specifications and must be suitable for installation of the pulse units of any remote

reading compatible devices of the international standards for the purpose of flow analysis and remote reading.

The flow meter must be supplied with a battery with life of 10 years without changing the battery unit and battery must be an integral part of the meter.

The salient features of the meter shall be as below:

- Transit Time technique or Time of Flight
- No moving, vibrating parts
- Full bore meter; no reduction in bore or separate measurement chamber
- Should not measure air
- Unaffected by grit and particles
- Low pressure drop
- Visual display and AMR
- No reverse flow measurement
- High pressure rating
- Continuous operation
- Tamper resistant
- Battery life of minimum 10 years
- Protection class IP 68
- Display – Liquid Crystal
- Maximum reading – 999999.999 m^3
- Minimum reading – 000000.000 m^3
- Should have interface facility to connect it with a remote reading equipment.

The flow meter shall comply with the following: -

S.No.	Item Description		Bid Requirement
(a)	Nominal Diameter	:	As per requirement

(b)	Accuracy	:	± 2% at maximum flow
(c)	Maximum Working Pressure	:	16 bars
(d)	Temperature range	:	0° C-50° C
(e)	Minimum flow rate	:	70 litre per hour for 25 mm, 200
		:	lph for 40 mm, 300 lph for 50 mm
		:	meters, 500 lph for 65 mm meters,
		:	750 lph for 80 mm meters & 1200
		:	lph for 100 mm meters
(f)	Maximum Flow rate		7 m^3/hr for 25 mm, 20 m^3/hr for 40
		:	mm, 50 m^3/hr for 50 mm meters,
		:	80 m^3/hr for 65 mm meters, 120
		:	m^3/hr for 80 mm meters & 200
		:	m^3/hr for 100 mm meters
(h)	Maximum permissible head loss	:	Less than 0.15 bar
(a)	at peak flow of respective village	:	As per requirement

11.9. **Woltman/ Multi-jet type bulk flow meter (Class B)**

The water meter shall be 50 mm to 300 mm nominal diameter Class B Bulk Water meters asper ISO:4064-1:2005 (E) (latest edition), BS 5728 and IS: 2373.
The water meter will be used for measurement of cold, chlorinated water supplied to domestic / non-domestic consumers.
The water meters will be manufactured in accordance with ISO-4064, BS 5728 and relevantIS standards (IS2373) latest revision and specifications stipulated herein. In case of anydiscrepancy, the decision of Engineer shall be final and binding.
The meters must have protection rating of IP67 or higher.
The meters must be tamper proof and hermetically sealed with lockable plastic seals withcopper wire provided by the water meter supplier. The bulk water meter shall not measureflow of air, if any. Recommendations shall be provided for ensuring such measurement.
The meter casing shall be Cast Iron/bronze and body shall be bronze/brass and shall beflanged at both ends. The meter body and cover shall be made from highest quality materialensuring resistance to corrosion. Meter body and cover are epoxy powder coated forprotection from any environment.

The meter parts coming in contact with water shall not create hazard and must be corrosionproof to withstand upto 2 ppm of residual chlorine in water.
The meters shall withstand maximum working pressure upto 1.6 MPa and conform to testingas per ISO:4064/BS 5728 and IS 2373 latest revision.
The functional working pressure shall be as per the working pressure available in the pipeline.
The meter shall include the following accessories suitable for flanged connection:
Set of short pipes, dismantling Joints & adaptors with flange connection.
Cast Iron strainer with stainless steel strainer element at inlet of same size.
The meters shall have protective devices which can be sealed in such a way that before andafter the water meter has been correctly installed, there is no possibility of dismantling oraltering the water meter or its adjustments device without damaging the protectioncharacteristics.
The meters shall have the following meteorological characteristics: Class 'B' as per ISO 4064. Imported water meters shall be EEC certified.
During Transportation for supply, the water meters shall be packed in containers or boxescontaining meters as per manufacturer's recommended practice.
The meters shall have analogue / digital indicating device. The meters shall be designed towithstand accidental reversal of flow without causing any deterioration / damage to the watermeters.
The water meters shall be designed for easy installation, easy disassembly and re-assemblywithout the application of special tools / gadgets.
The water meters shall be designed for intermittent flow. The installation consisting of flanged adapters, short pipe with flange, strainer, water meter shall be housed in a coveredchamber. Mandatory straightening length at both upstream and downstream of the watermeter as per standard practice of shall be provided.
The water meter shall be marked with the following identification:
Size, class and type of water meter, ISO No., Year of Manufacture, serial no. make of watermeter, country of manufacturer, Purchaser's name, direction of flow, rate of nominal flow andworking pressure.

S.No.	Item Description		Bid Requirement
	Type		
	Size and Quantity	:	50 mm to 500 mm as per contract specifications
	Class of Accuracy	:	Class B
	Manufacturing Standard	:	ISO 4064-1/2005 and IS 2373 with all amendments
	Testing Standard	:	ISO 4064 and IS 2373
	Pipeline/ Watermeter Orientation	:	Horizontal

	Tamper proof watermeter	:	To be provided
	MOC	:	Body : Cast Iron Construction
	Protection	:	IP 67
	Flow Coditions:		
	Max. low	:	As per ISO 4064/IS 2373
	Nominal flow	:	As per ISO 4064/IS 2373
	Min. flow	:	As per ISO 4064/IS 2373
	Pressure loss at nominal flow	:	As per ISO 4064/IS 2373
	Reverse flow	:	Restricted
	Accessories		
	Y Type Strainer	:	To be provided
	Meter shall be pulse/signal enabled for remote sensing in future	:	To be provided

11.10. **Level Measuring System**

11.10.1. **General**

i. The level transmitter shall be mounted in suitable weatherproof lockable pedestal enclosures near the level sensor.

ii. Float and board type level measuring system shall be additionally provided for level measurement and local display in each sump.

iii. Level monitoring devices (the level sensor equipment shall be secured to prevent interference by unauthorised personnel)

iv. The necessary bracketry to secure the instruments to be mounted near sump and surge tank.

v. Ultrasonic type level measuring devices shall comprise of a transducer, a transmitter, remote level indicator and all other items required to complete the control system.

vi. The level sensor and the field-mounted transmitter shall be separate and interconnected by integral cable of sufficient length.

vii. The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected as per IP65. It shall have ambient temperature compensation and adjustable datum setting facilities.

viii. The design and application of this ultrasonic level meters shall take into account the vessel or channel construction, the material size, shape, environment, process fluid or material, the presence of foam, granules, size etc.

ix. The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For application where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

x. The transmitter will provided an isolated 4-20mA 2 wire o/p.

xi. To remove the effect of water turbulence in reservoirs averaging facility should be provided in the transmitter unit.

11.11. Ultrasonic type Level Measuring System

(a) General

i. Accuracy of measuring loop :± 0.5% of full scale

(b) Sensor/transmitter **Split type**

i. Output : 4-20 mA

ii. Mounting : On top of sump

iii Range: As per requirement

iv Programming facility with programmer : Required

(c) Remote Display Unit : **Digital panel meter with** 3½ digit backlit LCD/LED, ± 0.25% accuracy, 4-20 mA high and low alarm set point, input 4-20 mA D.C.

(d) Analogue signal multipliers isolation : Required with galvanic and 2 outputs

Capacitance Type Level Measuring System

(i) The capacitance type level measuring system shall consists of a sensing probe, a transmitter and a digital indicator.

(ii) The level-measuring probe shall be installed on a standpipe on a tank and shall be connected to level transmitter which shall generate a DC analog signal for connecting it to the digital level indicator on the panel.

11.11.1. **Level Sensors (LS)**

Level sensors of capacitance type, suspension mounted shall be provided for level measurement of water in tanks/ sump/ reservoir. Guide pipe shall be provided for probe support.

11.11.2. **Technical parameters**

No	Title	Description
1	Name of instrument	Level sensor
2	Location	Outdoor/indoor on tanks/ sump/ reservoir
3	Application	Measurement of water level
4	Mounting	Flange /socket mounting
5	Input	Level
6	Output	DPDT contact rated 5A at 230 V A.C.
7	Accuracy	2.0% FSR
8	Required Range	To suit the requirement
9	Power Supply	230 V AC or suitable
10	Connection Details	2x1.5 mm2 CYWY cable

11.11.3. **Level Transmitter (LT)**

Level transmitter shall be provided for continuous level measurement. Level transmitter shall be of capacitance type with 4-20 mA output. Canopy arrangement shall be provided for each LT.

No	Title	Description
1.	Name of Instrument	Level Transmitter
2.	Location	Outdoor, Tank Mounted
3.	Application	Transmission of water level
4.	Mounting	Direct/Flange Mounted
5.	Input	Water level
6.	Output	4-20 mA
7.	Accuracy :	2.0% FSR
8.	Required Range	To suit the requirement
9.	Power Supply	230 V A.C. or suitable

No	Title	Description
10.	Connection Details	Single pair screened twisted core cable
11.	Enclosure	Al Diecast, Weather Proof ,IP65

11.11.4. **Level Indicators (LI).**

Level indicators shall be digital, flush mounted, 7 segment red LED indication type and shall be provided on the control panel for continuous level indication at sump/ tanks/ reservoir. Each level indicator shall have input of 4 - 20 mA from respective field mounted level transmitter.

No	Title	Description
1	Name of Instrument	Level Indicator
2	Location	Control panel
3	Mounting	Flush mounting
4	Application	Water level
5	Input	4-20 mA from Level transmitter
6	Output	Digital display
7	Power supply	230 V A.C. or suitable
8	Display	7 segment LED with 3 ½ digit display

11.12. **Pressure Measuring System**

11.12.1. **General**

Service	:	As per requirement
Accuracy of measuring loop	:	± 0.5% of reading or better

11.12.2. **Pressure Sensor & Transmitter**

Sensor	:	Diaphragm Sensor 2 wire type
Wetted parts material	:	SS 316
Range	:	Adjustable over full span

Zero & Span Adjustment	:	Required
Output signal	:	4-20mA, DC
Enclosure Protection	:	IP 65 of IS 13947 (Part I)

11.12.3. **Display Unit**

Remote display Unit		Digital panel meter with 3½ digit backlit LCD/LED, ± 0.25% accuracy, high and low alarm set point, input 4-20 mA D.C.

11.13. On line chlorine analyser

The on line chlorine analyser shall comply with the following: -

1.0	**General**	
1.1.	Instrument range	0-5 PPM
1.2.	Resolution	0.01 PPM
1.3.	Accuracy	+/- 0.05 PPM or better
1.4.	Response time	90% in 60 seconds
1.5.	Unit displayed	PPM
1.6.	Temp units	°C, °F
2.0	**Sample conditions**	
2.1	Process temperature	-5 TO 70 DEG C
2.2	Inlet pressure:	4 BAR
2.3	Flow rate:	> 30 Lit/Hr
2.4	Minimum conductivity	>150 MICRO S/CM
2.5	Sample connections	DN 6/8 TUBE FITTINGS
3.0	**Sensor**	
3.1	Electrodes	POTENTIOMETRIC FREE CHLORINE SENSOR

3.2	Membrane/electrolyte	NOT REQUIRED
3.3	Self cleaning	AUTOMATIC SELF CLEANING SENSOR
3.4	Calibration	PROCESS CALIBRATION
4.0	**Transmitter**	Microprocessor based
4.1	No. Of analog outputs:	3 CURRENT Outputs , OPTIONAL – HART*
4.2	Display	GRAPHIC 128X64 PIXELS
4.3	Output selections	0-20 mA, OR 4-20 mA
4.4	Alarm outputs	3 relays (NO/NC) FULLY PROGRAMMBALE
4.5	Ph compensation	AUTO/ MANUAL COMPENSATION*
4.6	Power supply	100--230 VAC 50/60 HZ OR 24VAC/DC
4.7	Other features	CALIBRATION LOG, STATUS LOG,TEMPERATURE COMPENSATION
4.8	Size	As per requirement

11.14. Microprocessor based Alarm Annunciator

11.14.1. General

a) Microprocessor based alarm annunciators shall be provided for generating audio visual alarms for each abnormal condition as defined in scope of work. Alarms shall be initiated by the opening and closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exist. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special equipment. Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the

maximum sound level of its environment. The sequence of alarm should be user selectable by dip switch.

b) The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a future alarm condition occurs.

c) Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.

d) Isolation facilities shall be provided for the hooter using an MCB

e) Alarm annunciator/indicator legends or labels shall be arranged with three lines of text as follows :

f) The annunciator will be split architecture type and the facia will have LEDs.

11.14.2. **Technical**

Alarm annunciator shall be provided on instrument control panel for annunciation of alarms in control room. The technical particulars of alarm annunciator are as follows:

(a) Technical Particulars

i.	Type	:	Microprocessor based, split type with alarm windows mounted on the front door and electronic modules inside the panel
ii.	Mounting	:	Flush with panel
iii.	Construction	:	Modular
iv.	Inputs	:	Potential free, NO/NC contacts
v.	Size of windows	:	60 mm X 26 mm
vi.	Operating sequences	:	First up (user selectable dip switch)
vii.	Bulbs per channel	:	2 (Cluster LEDs)
viii.	Push Buttons	:	For Reset, Accept and Test
ix	Hooter	:	Required, electronic type
x	Power supply	:	24 V DC/240 V AC
xi.	Power supply status	:	Required indication
xii	Weather protection	:	IP-52 of IS 13947
xiii	No. of Windows	:	120 Nos. min

11.15. **Lightning Protection Unit (L.P.U.)**

Two numbers of lightning protection units shall be provided for each signal loop. The lightning protection unit shall be suitable for withstanding the surge arising out of high

energy static discharge/ lightning strikes and prevent the instrument from any damage. LPU shall provide three stages of protection through a gas discharge tube, quick acting semiconductor like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. LPU shall be a passive unit and shall require no power for its operation. During a lightning strike it shall clamp on the allowable voltage and pass the excess voltage to the ground. LPU shall be of self resetting type to minimize the down time of the measurement loop. LPU shall have a weather proof casing and shall be suitable for field/back of panel mounting. LPU provided shall be suitable for connecting in 24 V / 48 V, 4-20 mA DC signal lines. There should be total isolation between input, output and ground terminals. The LPU shall have a minimum surge rating of 10 KA.

11.16. **Digital Panel Meters**

Digital Panel Meters (DPM) for pressure and level monitoring shall be microprocessor based and modular in design. They shall accept 4-20 mA DC signals from transmitters. The DPM'S shall have backlit LCD/LED display.

11.17. **Analogue Signal Multipliers**

The flow, level and pressure signals shall be provided with back of panel mounted signal multipliers. They'll provide loop power with option to select measurement with power and without. The multiplier will provide 2 outputs of 4-20mA one for the panel mounted indicator. There will be total galvanic isolation between field I/Os and also between the 2 outputs.

11.18. **Cabinets For Field Instruments**

A Cabinet shall be provided for enclosing instruments and associated accessories which are mounted outside the control panel such as transmitter, LPU, terminal blocks etc. at all measurement locations.

It shall be fabricated from cold rolled steel with powder coating sheet of standard gauge and shall be suitable for wall mounting or pedestal mounting as required.

The cabinet shall conform to IP-65 protection and shall have built in locking facility. The cabinet shall be earthed properly. A steel plate/pipe, as per the requirement, shall be provided in the cabinet for mounting the instrument and accessories.

11.19. **Instrument Power Supply Cables And Instrumentation Signal Cables**

Cables shall be capable of satisfactorily withstanding without damage, transportation to site, installation at site, and operation under normal and short circuit conditions of the various systems to which the respective cables are connected when operating under the climatic conditions prevailing at the site as indicated in this specification.

Cable joints in instrument signals and power supply cables shall not be permitted.

Cables shall be capable of satisfactory performance when laid on trays, in trenches, conduits, ducts and when directly buried in the ground.

Cables shall be capable of operating satisfactorily under a power supply system voltage variation of ±15%, a frequency variation of ±5.0% .

11.20. **Instrumentation Cables**

11.20.1. **Cables for Digital Signals and Power Supply to Instruments**

660V/1100 V grade multicore cables, multistranded high conductivity annealed 1.0/1.5/2.5 sq.mm stranded tinned copper conductor, extruded PVC insulated, with aluminium mylar tape, ATC drain wire run continuously in contact with aluminium tape, inner sheathed with extruded PVC, armoured with galvanised steel wire overall sheathed with extruded PVC conforming to IS:1554 & IEC:189 Part II.

11.21. **Laying Of Cables**

A distance of minimum 300mm shall be maintained between the cables carrying low voltage AC and DC signals and a distance of minimum 600mm shall be maintained between cables carrying HT and LT signals. In outdoor areas, the cables shall be directly buried. Each instrumentation and power supply cable shall be terminated to individual panel/ terminal box. Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.

Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for Engineer's Representatives approval.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. A loop of 1 meters shall be left near each field instrument before terminating the cable.

Cables shall be complete uncut lengths from one termination to the other.

All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules. Identification tags shall be securely fastened to the cables at both the ends.

Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.

11.22. **Programmable Logic Controllers**

11.22.1. **Codes and Standards**

The design, material, construction features, manufacture, inspection and testing of Programmable Logic Controllers (PLC) shall comply with all currently applicable statutes, regulations and safety codes. The PLC shall comply with the latest applicable standards and codes or shall comply with the available recommendations of professional institutes like NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE.

11.22.2. **Design and Construction Requirements**

a) The PLC shall be provided as a standalone controller to perform combinational and sequential logic functions, status monitoring and reporting functions with relays, counters and timer facilities.

b) The PLC shall have the following attributes as a stand alone controller:

- It shall carry out computation and interfacing for data acquisition, data storage and retrieval.
- It shall accept downloaded program from a programmer.
- It shall have different functional modules to perform the desired functions.
- It shall scan the inputs in time cycles and update the status of inputs/outputs.
- To avoid spurious output because of output module failure, all commands shall be associated with release signals. Release signals shall include information on healthiness of the hardware, software and power supply modules.
- It shall have relays, counter, timer functions, internal registers and flags, watch dog timer, set-reset facilities, up-down counter etc.

c) The PLC system shall be expandable and shall be modular in construction so as to carry out future expansions.

d) The PLC shall have analog and digital signal monitoring capability for checking the healthiness of the signals. In case of detection of any unhealthy signal 'PLC trouble' alarm shall be generated.

e) The PLC shall provide power supply to instruments / transmitters / sensors / transducers which are connected as digital or analog inputs, as applicable and also for analog outputs.

f) PLC shall use industrial and open standard protocols and structures for communication.

g) The PLC should have the facility of the Web Server

h) The PLC should support firmware upgrades through network

i) The PLC should have facility of storing intermediate variables

j) The PLC firmware and applications shall run on a real-time, multi-tasking operating system. Microprocessor module shall have at least 64 MB of battery backed RAM, and 2 MB flash EPROM. The PLC memory shall be arranged and sized to hold, in addition to all necessary programs, the data for a period of operation in the event of communications failure.

k) PLC CPU clock speed should be more then 350MHz.

l) In case of system failure or power supply failure all the outputs shall attain pre-determined fail safe condition e.g. stopping of pumps or closing of valves.

m) The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

n) It shall be possible to perform the simulation functions and testing the program by changing the status of contacts and monitoring the output.

o) Communication modules shall be provided in the PLC for establishing the communication links with the central SCADA system. There will be two communication links for redundancy purpose. The Contractor shall provide all the information, data, protocol details and test facilities for establishing the exchange of bidirectional data between the central SCADA system and the PLC systems at each of the pumping stations.

11.22.3. **Central Processing Units**

a) The Central Processing Unit (CPU) shall be high performance processors with modular configuration suitable for real time process application. High inherent reliability, self checking, error-recovery and trouble-shooting features shall be the features of CPU.

b) The following additional features shall be provided.

c) Communication between CPU and other modules / peripherals shall be by an I/O bus. The individual device, interfaces shall be capable of being plugged into the I/O bus.

- On resumption of power, following a power failure the PLC shall automatically restart its controlling function.

d) CPU shall have a real time clock capability to accept a time synchronisation pulse from external communication system and adjust its internal clock with the pulse.

- CPU shall have extensive self diagnostic facilities and watch dog timers to identify faults at card levels
- The CPU word length shall be 16 bit or more. The CPU shall have at least 50% spare capacity after commissioning of the application

11.22.4. **Memory Unit**

a) Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for upgradation and expansion of memory to meet future demands. The CPU should have min 64 MB RAM to cater to current and future program additions.

b) Memory loading should not be more then 50%. System initialisation and application software shall be stored in Memory with necessary hardware. Running data shall be stored in a RAM with internal battery back-up. Appropriate programs for application software modification shall be provided.

11.22.5. **Input / Output Modules**

a) Standard rack mounted I/O modules with plug-in cards shall be provided. Field wiring shall be terminated in the terminal blocks and interconnected to the processor I/O system with pre-fabricated cables and plug in card type connectors.

b) Some of the common features of the I/O modules shall be as follows:

- inputs shall be opto isolated
- filters shall be provided for noise rejection
- input /output status shall be indicated by an LED
- all outputs shall be fuse protected and have fuse failure indication
- the fuses may be mounted externally from the output module
- all the modules shall be of addressable type
- The I/O modules shall have diagnostic features i.e., in case of failure of any I/O channel an alarm 'PLC trouble' shall be generated automatically

c) Analog Input Modules

They shall consist of an input isolation unit, signal conditioning unit and an analog to digital converter (ADC). In addition, the following features shall be provided:

- cross talk attenuation
- provision for monitoring of the ADC for overflow detection
- gain amplifier with high common mode rejection ratio
- accuracy for analog signals shall be minimum +/- 0.5%.
- terminals with fuse and LED for indication of 'fuse blown' shall be provided for each analog input

d) Digital Input Modules

The following design features shall be provided.

- contact bounce protection
- choice of type of contacts
- terminals with fuse and LED for indication of 'fuse blown' shall be provided for each digital input.

e) Digital Output Modules

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows :

- contact bounce protection
- relay output to operate pump motors and motorised valve actuators
- fail safe position in case of output module failure and fault indication

11.22.6. **Communication Modules**

Communication modules shall be provided and installed in the PLC rack for digital communication to external devices. The types of modules shall be selected to suit the devices being connected, the distance / cable length required and speed of communication.

Communication modules shall be provided for interfacing with the central SCADA system over two telecommunication links.

11.22.7. **GSM-GPRS Communication Network**

The proposed Intelligent GSM-GPRS communication unit shall be of GSM – GPRS communication network capability.

Reliable Integration: The modem should be very tightly integrated with the PLC network.

The failure of Global System for Mobile Communications- Global Packet Radio Service of one of the service provider during maintenance or power failure in the cell towers or cell channels switching center, etc. the PLC should store data in file the web server shall be unable to transfer. Data will be transferred to central location in secure manner. Consider static IP as per requirement. No data loss in case of no connectivity. Direct connectivity to GSM modem for Alerts as well.

11.22.8. **Operator Interface**

An operator interface shall be provided and shall be installed on the control panel front facia. The operator interface shall include all the features indicated below to facilitate the operator for operational purpose:

- Display status of plant in graphical form
- Display status of pumps and valves
- Annunciate alarms
- Provide facilities for carrying out operations of valves and pumps.

The operator interface unit shall have a coloured LCD screen and a keypad / touch screen.

11.22.9. **Default Values**

Every operator selectable parameter shall be provided with a default value held in EPROM or EEPROM in the relevant PLC.
Sensible and logical default values shall be inserted prior to the start of system tests. The default values at the time of handing over the plant shall be those found operationally suitable during commissioning.

11.23. **PLC Software**

a) Wherever applicable PLC programming shall be carried using latest available industrial standard formats for logic. The PLC programming shall be prepared using the PLC manufacturers recommended windows based PLC coding and documentation software. The PLC code shall be structured in the manner of the best industry standard and have comprehensive subroutine and rung annotation. The PLC programming languages shall be industry standards such as Ladder language, Instruction List Language or graphcet language.

b) The PLC software shall provide the facilities to carry out the operations of the pumping station described in the control system and control philosophy, which shall include the following:

- operations in various modes
- Selecting number of pumps to be operated based on desired flow
- Starting or stopping of pumping station with a single command
- Checking of permissive conditions to start
- Sequence of start / stop of pumps alongwith associated suction and discharge valves.
- Duty cyclic operations
- Pumping station operations in line with upstream and downstream pumping stations operational data

11.24. **SCADA System**

The system at MCS shall consist of following hardware as a minimum:

a) Two SCADA servers each Microsoft Windows based with hard disks & backup, main memory, alphanumeric & functional Keyboards, mouse, Power supply units etc.
b) Two operating stations each Microsoft Windows based with hard disks & backup, main memory, alphanumeric & functional Keyboards, mouse, Power supply units etc.
c) Front End Processors (FEPs).
d) Industrial grade 24 port LAN Switch.
e) One no. A4 multi function b/w laser jet printer.
f) SCADA Cabinets (for housing the SCADA equipments) including power distribution panel
g) Communication interfaces including cables.
h) Console desks, server desks, SCADA cabinets
i) Auxiliary equipments including cabling, connectors, interfaces etc.
j) Leased line and static IP connection.
k) 46 inch video wall /LCD smart screen.
l) ISDN and GPRS modems for telecommunications complete with all wiring and installations.
   Any other items required to fulfill the requirements and functionality of the tender shall be supplied and included as part of lump sum price by the Contractor.

The SCADA System shall be provided with proprietary Microsoft Windows based Supervisory Control And Data Acquisition (SCADA) software. The software package chosen shall be branded and written for applications in water industry and shall have a proven record of use for water pumping stations having similar applications

The SCADA System shall consist of industrial grade PC and SCADA software package. A line printer shall be provided for alarm and event logging and report preparation

The SCADA System shall provide the following facilities:

a) Display status of all the items of the pumping station, SR, DMA viz. pumps, valves, switchgears, instruments etc. in a graphical and tabular format (i.e. running, stopped, fault etc.)

b) Display analog values on the appropriate graphic screen

c) Annunciate alarms along with time of occurrence of alarm. The software chosen shall have a comprehensive alarm handling capability with the ability to annunciate, acknowledge, sort and maintain a historic record of current and past alarms including details of when the alarm occurred, when it was acknowledged and when it returned to normal

d) Provide facilities for the operator to:

- Select duty and standby drives
- Adjust process set points
- Select operation modes
- Acknowledge alarms
- View a journal of alarms
- Display the duty / standby status drives
- Display set points

e) Provide real time and historic trending of analogue values

f) Provide data archiving of all analogue values

g) Prepare daily and weekly reports, providing details of daily and weekly throughputs against numbers of pump running hours and power usage

h) Display total running hours of pump drives

i) Any additional features required to assist in the effective and efficient operation of the pumping station.

j) Password protection shall be provided for security of operations, change of set points and changes in the software. There shall be various levels of security.

k) Printing of alarms and events alongwith the time of occurrence.

11.24.1. **Uninterruptible Power Supply**

The Contractor shall provide Uninterruptible Power Supply (UPS) unit for providing power supply to the SCADA system.

- The UPS shall be sized to provide 8 hours of full load.
- The UPS shall have the following features:
- It shall be floor mounted, self contained, metal clad and free standing type panel enclosure.
- The door of the enclosure shall be in the front.
- The UPS shall be on-line type and shall be microprocessor controlled. It shall contain a static bypass switch which shall operate in the event of UPS failure,

overload or manual initiation in order to transfer the load to mains without interruption to power supply.

- The UPS shall incorporate a dc under voltage trip circuit to electronically trip the UPS output in order to protect the batteries. The noise level of the unit shall not exceed 60dB (A) at 1 m from the UPS cabinet. The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non linear load. It shall be suitable for load power factors 0.7 lag to 0.9 lead. The unit shall have a dynamic response such that a 100% step load causes an output voltage transient of less than ± 4% with a recovery time of less than 4 ms. For three phase output units the output voltage shall not vary by more than ± 1% for an unbalance of 10%. The load crest factor shall not be less than 3:1. The efficiency at full load and 0.8 power factor shall be greater than 88%.
- Indicators to indicate
    - UPS status
    - UPS alarm conditions
- The UPS shall provide a volt free contact output to indicate:
    - warning, i.e. low battery capacity
    - fault
    - static bypass in use
- The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output. The batteries shall be housed, within the UPS enclosure The batteries shall be maintenance free lead-acid type sealed for life. Batteries shall be contained within translucent impact resistant flame retardant polypropylene cases. They shall have life in service of at least 10 years. Terminals shall be shrouded to prevent accidental contact. The battery enclosure shall be corrosion resistant and ventilated to prevent the build up of gases. Warning notices shall be provided for wall mounting to warn of the presence of charge gases. The battery supply to the UPS shall be via a fused load break switch disconnecter circuit breaker.
- The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.

The outdoor type panel housing the electric meter, UPS and batteries, MCB DB Panel and PLC/RTU shall be prefabricated out of CRCA sheet steel of thickness not less than 2 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. The panel shall have dimensions as per system requirement.

11.24.2. **Additional Requirements**

The relevant clauses from electrical and mechanical subsections of general requirements regarding items or works of electrical or mechanical nature shall be applicable to ICA equipment.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 12. Specifications for Road Work

12.1. General

This part of the specification covers the construction of roads and cross drainage structures, within the project area. Setting of work, procedures for laying and compaction, and workmanship for the road items and the material and workmanship of civil construction items of cross drainage structures are to be carried out as per the provisions laid down in this Chapter. Wherever the details of any item are not mentioned in these specifications, but which are essential to be executed, the specifications for those material / item of works shall be read as specified in "Ministry of Surface Transportation Indian Road Congress Special Publication No. 13.

Further wherever use of mechanical machines for excavation, laying, grading activities has been referred in MOST specifications or in this chapter, contractor shall be allowed to use skilled labour for such excavations, laying and grading provided that the quality of finished surface of road satisfies the specifications laid in this chapter for respective items of road.

12.2. Specification of CC Road

12.2.1. General

This part of the specification covers the construction of roads and cross drainage structures, within the project area. Setting of work, procedures for laying and compaction, and workmanship for the road items and the material and workmanship of civil construction items of cross drainage structures are to be carried out as per the provisions laid down in this Chapter. Wherever the details of any item are not mentioned in these specifications, but which are essential to be executed, the specifications for those material / item of works shall be read as specified in "Ministry of Surface Transportation Indian Road Congress (MOST)

Further wherever use of mechanical machines for excavation, laying, grading activities has been referred in MOST specifications or in this chapter, contractor shall be allowed to use skilled labour for such excavations, laying and grading provided that the quality of finished surface of road satisfies the specifications laid in this chapter for respective items of road.

12.2.2. **Definitions**

MOST: means the clauses/sections of the publication no. of Ministry of Surface Transportation.
IRC: means Indian Road Congress Special Publication

12.2.3. **Scope of Specifications**

This part of the specifications shall apply to all such road and allied works as are required to be executed under the contract. It shall cover site clearance, construction/ preparation of earthen embankment, base course, wearing course and other associated civil works and maintenance of the constructed road for 5 (Five) years. Contractor shall provide a Service road of 3.75m wide carriage way with all associated CD and other works. In case of any discrepancy or undefined specification, the MOST specifications shall prevail. All road structures, if otherwise not specified shall be constructed in accordance to the provisions and principals laid down in the IRC publication.

The components of road construction work shall include following but not limited to:

12.2.4. **Excavation**

Making excavation for roadwork or Preparation of earthen embankment Preparation of sub grade.

If black cotton soil / clay soil found in excavation, this soil shall be removed and non-clay soil as per MOST specification shall be used in refilling and refilled soil shall be compacted upto 100% of standard proctor density.

The sub grade whether in cut or fill shall be well compacted to utilize its full strength and to economies thereby on the overall thickness of pavement required. A top 50 cm portion of the road way shall be compacted upto 100% of standard proctor density. In water logged areas, the level of formation shall be above flood level at least by about 0.6 to 1.0 meter.

12.2.5. **Base- course**

100 mm thick Base- course will be laid in cement concrete M15 (1:2:4). Material for concrete shall be as per specification given in chapter 6 of Vol.-II of tender document.

12.2.6. **Wearing Courses**

It shall consist of:

- ❖ Surface dressing as wearing course consisting of reinforced cement concrete layer by cover of uPVC sheet as per specification.
- ❖ 150mm thick reinforced cement concrete in M25 in nominal reinforcement with providing camber as per specification
- ❖ Concrete shall be laid in panels and gap between panels shall be 12.5 mm. This gap shall be filled by filler material like bituminous asphalt as per IRC specification.
- ❖ Curing of CC road shall be done as per relevant IS code.

12.2.7. **Shoulder Construction**

1.875m wide shoulders on both sides of carriage-way of earthen/ granular material shall be constructed out of which 1.0 m shall be treated with granular sub-base and remaining shall be earth shoulder.

12.3. **Preparatory Works**

The required survey for preparation and planning of road shall be done. Survey data, the Contractor shall, submit to the Engineer-in-Charge for his approval, a profile along the road center line and cross-sections at intervals as required by the Engineer-in-Charge.

Alongwith the L-section contractor is to decide the locations and type of cross drainage and road/canal crossing structures. The hydraulic and structural design of all such works must be got approved from the Engineer-in-Charge before execution of works.

12.4. **Methodology and Sequence of Work**

Prior to start of the construction activities at site, the Contractor shall submit to the Engineer-in-Charge for approval, the detailed construction methodology including mechanical equipment proposed to be used, sequence of various activities and schedule from start to end of the work. Programme relating to casting of road and shoulder construction shall be an integrated activity to be done simultaneously in a coordinated manner. The methodology and the sequence shall be so planned as to provide proper safety, drainage and free flow of traffic.

12.5. **Site Clearance:**

This work shall consists of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc. which in the opinion of Engineer-in-Charge are unsuitable for incorporation in the works from the area of road land containing road embankment, drains, cross drainage structures and such other areas as may be specified on the drawings or by the Engineer-in-Charge. It shall include necessary excavation, backfilling, of pits resulting from uprooting of trees and stumps to required compaction, handling,

salvaging and disposal of cleared materials. Clearing and grubbing shall be performed in advance or earthwork operations and in accordance with the requirements of these specifications.

During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution etc. and where required undertake additional works to that effect. Before start of operations, the contractor shall submit to the Engineer-in-Charge for approval, his work plan including the procedure to be followed for disposal of waste materials etc. and the schedules for carrying out temporary and permanent erosion control works.

All materials arising from clearing and grubbing operations shall be the property of Government and shall be disposed of by the contractor as hereinafter provided or directed by the Engineer-in-Charge.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked.

All products of clearing and grubbing which in the opinion of the Engineer-in-Charge can not be used or auctioned shall be cleared away from the road side in a manner as directed by the Engineer-in-Charge. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixing up with the materials meant for embankment.

12.6. **Miscellaneous Works**

The contractor under this scope of work is also required to maintain the road in clean conditions, which includes the cleaning of stones, fallen trees, dead animals etc.. as and when noticed by the patrolling teams or as directed by the Engineer-in-Charge.

The pipe culverts and the other cross drainage structures built or rehabilitated under the contract will be regularly inspected and suitable cleaning, grading works will be done to maintain impounding near the structures. The structural damages will be repaired or dismantled and re-constructed considering the extent of damage as per directions of Engineer-in-Charge.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 13. Specifications for Surge Control System

13.1. Design of Control System

The contractor shall design each main for the surge protection system. In accordance to the design requirement the required instruments shall be provided, irrespective to the fact that they are not mentioned in the scope of work. No additional payment shall be given on this account shall provide the detailed surge analysis at his level. In case of difference of opinion between the Engineer in Charge and the contractor, regarding any analysis the case shall be referred to IISC Bangalore, whose opinion shall be considered final for the purpose of providing necessary equipment / for taking necessary measures against surge protection system for the main.

13.2. ACCEPTED CONTROL SYSTEM

Any control system recommended by the designer can be adopted subjected to approval by Engineer-in-Charge.

The Air Vessels, Zero velocity valves or any other equipment used for the Surge Protection System must be procured through the manufacturer who have previous experience of manufacturing such systems. The manufacturer shall submit certificates of test results of at least two systems manufactured and installed by him with diameter of the main not less than 200 mm. For Air Vessels, the manufacturer must produce test results on at least two schemes with volume of the vessel larger than half the volume of vessel recommended by the surge designer in respective case. In case of on way surge tanks, the valves used should be of reputed and accepted make with proper opening characteristics.

13.3. Technical Specifications FOR AIR vessel system.

The Technical specification provided for, cover only Air Vessels and zero velocity valves. In case of alternative system of surge protection as recommended by the designer, the detail specification of the same shall be submitted by bidder for approval of the Engineer-in-Charge.

13.3.1. Air Vessel

13.3.1.1. General specifications :

Air Vessel should be suitable to take care the water hammer occurring in the pipe line system of raw/clear water mains on which they are proposed. The Air Vessel will be

manufactured out of MS plates as per IS 2002 or equivalent. The design and fabrication will be carried out as per latest version of IS 2825. Air Vessel will be provided with manhole and water outlet at the bottom, which will be connected to the rising main along with an isolating valve and a differential orifice. Suitable drain will be provided for maintenance. Air Vessel will have standard fittings such as pressure relief valve, visual level indicator, control circuit inlet and outlet etc, with isolating valve.

Two air Compressors shall be supplied along with the vessel.

The Compressor will be operating at slightly higher pressure than the line pressure, and compressed air will be stored in the receiver from which requisite supply will be made to Air Vessel.

The Air Vessel and air receiver will be painted internally and externally with zinc rich food grade epoxy paint.

The following additional equipment will be supplied as standard accessories to the Air Vessel:

- ❖ Receiver with compressor, with automatic on/off system.
- ❖ Visual water level indicator, covering full height or length of the air vessel.
- ❖ Isolating and drain valves for maintenance purpose.

Working of automatic level control system:

The automatic control system shall be generally as described below. Contractor may propose alternative arrangement.

Operation:

A compressor with receiver shall be provided to get compressed air in receiver. Compressed air is stored at higher pressure than working pressure of pumps to avoid frequent 'on' 'off' of compressor.

To maintain the level in the vessel between the working limits, electrical/electronic level control system shall be provided.

The system will basically consist of following:

1. Level Sensors:

Level of water is sensed at five levels. Their significance is given below: -

(a) Upper emergency level

(b) Upper working level

(c) Mean working level

(d) Lower working level

(e) Lower emergency level

2. Solenoid Valves with indicator lamps:

(i) Upper emergency level: In case, due to faulty operation or otherwise, water level rises further to level (b) and reaches level (a), then both the solenoid valves for entry of air will open to pass on more air in the vessel. Simultaneously, an alarm is started for operation. Operator should attend the same by pressing 'Reset' and

starting manual inlet. When water level reaches mean level both solenoids valves are off along with indicator lamps for same.

(ii) Upper working level: Due to dissolution of air, water level rises in the vessel. When the water level reaches this level, one solenoid valve is on and air is passed from receiver to Air Vessel, corresponding indicator lamp is on.

(iii) When sufficient air is passed and water level reaches 'Mean' level then solenoid valve is off and all lamps are off.

(iv) Mean working level: Water level in the vessel is required to be maintained around this level and between levels (b) & (d). At this level all control solenoid valves are in off position.

(v) Lower working level: In case of drop in the pressure or excess of air in the vessel, the level in the vessel drops down, one Solenoid valve for exhaust of air is on along with indicator lamp and air from vessel is let out. When water level reaches the mean working level then solenoid valve along with indicator lamp is put off.

(vi) Lower emergency level : In case of faulty operation or otherwise, the level in vessel drops down then the second solenoid valve along with indicator lamp is put on to discharge more air from blow off valve provided on the vessel.

(vii) When water level reaches 'Mean' level, both the solenoid valves are off with indicator lamps.

13.3.1.2. **Constructional features :**

Capacity of Air Vessel	As per design/recommendations of consultant.
Design Pressure	As per design/recommendations of consultant
Installation	Vertical / Horizontal
Size of differential orifice	As per design/recommendations of consultant
Size of Gate Valve	As per design/recommendations of consultant
Pressure gauge (0-16Kg/cm2)	150mm dial size with needle type isolation valve

13.3.2. **Air Compressor**

13.3.2.1. **Standards**

SN	Standard	Title
1	IS 10431 / 1994	Measurement of air flow of compressors and exhausters by nozzles
2	IS 9242 / 1986	Rated pressures of air compressors
3	IS 7938 / 1976	Specification for air receivers for compressed air installation
4	IS 2062 / 1992	Steel for general structural purposes
5	IS 2041 / 1992	Steel plates for pressure vessels used at moderate & low temperature
6	IS 11461 / 1985	Code of practice for Compressor safety
7	IS 11465 / 1985	Technical supply conditions for Reciprocating Air Compressors for power up to 25kW

13.3.2.2. **Constructional Features**

The Compressors shall be Reciprocating type, air cooled, electric motor driven through belt drive. The compressor and motor shall be mounted on common fabricated steel base plate with suitable belt guard.

The crank shaft shall be precision balance. Bearing shall be adequately sized for heavy duty. Crank pin bushing shall be replaceable and precision ground.

Inter cooler shall be made of finned copper tube and provided with safety valves to prevent over pressurisation.

Connecting rod shall be made in one piece with solid end construction with integral splash lubrication.

Cylinder shall have large number of radial fins to dissipate heat. Cylinder bore shall be smoothly machined. Cylinder head shall be easily accessible for inspection.

Pistons shall be designed for a smooth running and fitted with compression rings and oil control rings suitable for high pressure and minimum wear. Valves shall be made of stainless steel for wear resistance and longer life.

Piston displacement	As per design/recommendations of consultant
Maximum working pressure	As per design/recommendations of consultant
Method of starting	Auto start - Stop with DOL starter set to Start : As per design/recommendations of consultant Stop : As per design/recommendations of consultant
No of Compressors	2 Base mounted Compressors with one receiver of 1m^3 at each site

13.3.3. **Safety System**

The compressor unit must be equipped with following safety equipment

(i) Safety valve

(ii) Automatic shut down for high discharge air temp.

13.3.4. **Instruments**

The compressor unit shall have following instruments

(I) Air discharge temp gauge

(ii) Air discharge pressure gauge

13.3.5. **Out put**

The compressor shall be capable of delivering free air at rated discharge and pressure measured in accordance with IS 5456 - 1969 with modification that the performance be given at the out let of air receiver.

13.4. **TECHNICAL specifications for zero velocity valve system**

13.4.1. **Zero Velocity Valve**

The valve shall have an outer fabricated casing ('Main Body') in which a 'Central Rod' is held by struts. The 'Stationary Central Dome' creating an annular streamlined passage for smooth flow of water shall be provided. Closing Disc shall be mounted on 'Central Rod'. Disc shall be held in closed position by number of 'Stainless Steel Springs' (as per AISI 304). Two 'Anti Rotation Guides' shall be provided on the edge of 'Central Disc' with minimum resistance to flow. 'Anti Rotation Guide' shall be claded with Stainless Steel Strip (as per AISI304) and 'Guide Fork' with brass liners. A 'Bypass' shall be provided with a 'Valve' connecting upstream and downstream sides of valve. A 'Man Hole' shall be

provided on 'Outlet' cone of main body, for maintenance and replacement of spring (if required) without removing the valve from line. The 'Outer Shell', 'Dome' & 'Disc' shall be fabricated out of M.S. plates as per IS 2062. A stainless steel sleeve (as per AISI 304) shall be fitted on 'Central Shaft' which moves in brass bush in 'Disc' for free movement. The Valve shall be painted in Zinc Rich Epoxy Paint from inside and outside.

13.4.2. **Air Cushion Valve**

The valve shall have of a 'Main Body' and 'Top Housing'. On the side of main body, two 'Air Inlet Valves' loaded with a light spring shall be fitted. The 'Inlet' shall be protected by a cover. The 'Top Housing' shall have an opening for air escape. A spring loaded 'Poppet' with a brass seat and Neoprene 'Sealing Ring' shall be provided to covers the top of the opening. The spring pressure on the valve with adjustable screw (S. S. as per AISI-304) shall be provided. The 'Housing' shall have a tapered outlet, the opening of which shall be adjustable by a tapered plug and Screw (S. S. as per AISI-304). The outlet shall be protected by a cover. On its lower side a cage holding a ball float shall be fitted. 'Main Body', 'Top Flange', shall be fabricated from MS (as per I.S.2062/I.S.1239). The 'Top Housing' shall be made from high grade cast iron. Main body, float ball and air inlet flange shall be tested for hydraulically pressure. Stems of valves shall be are of stainless steel (as per AISI-304). Sealing rings shall be of good quality rubber and seats shall be of brass. The 'Valve' will be painted in Zinc Rich Epoxy Paint from 'Inside and outside'.

13.5. **Pipes**

All MS/CI/DI pipes used for the surge protection system shall comply with the provisions laid down in Chapter 3 of Vol. II of Bid Document.

13.6. **Valves**

All valves used for the surge protection system shall comply with the provisions laid down in the Chapter 4 of Vol. II of bid document.

13.7. **Non-return Valve**

The specifications of non-return valve shall be as given in chapter 4 of this volume.

13.8. **Float Valve**

The specifications of float valves shall be as under:

S. No.	Particulars	Required specifications
1	Conforming to	Generally to G&K Catalogues

2	Size	As per BOQ
3	Body test pressure	1.4 Mpa
4	Float size	As per Catalogue
5	Material of construction Body, valve, Fulcrum bridge, Bottom plate Washer plate, Seat ring, Link Liner, Pin, Eye bolt for valve Lever, Lever fork and Jam nut Valve face and Valve cup Ball float	 CI, GR:FG200, As per IS210 GM as per IS:318 Brass MS as per IS:226 Synthetic rubber Copper
6	Flange	As per IS:1538
7	Tests to be carried out	Hydraulic test of the valve body

Chief Executive Officer

Udaipur Smart City Limited

Chapter 14. Pre-Dispatch Inspection

14.1. Pre-Dispatch Inspections and Tests

The contractor shall submit a Quality Assurance Programme (QAP) for each item for approval of Engineer-in-Charge. Actual manufacturing shall start only after approval of QAP.

It is proposed to get the equipment and material listed in the table below, inspected prior to dispatch for work site through third party (authorized by the Department)/project consultants/departmental engineer(s).

S. No.	Equipment/Material
1	All type of pipes
2	All type of Valves
3	All pumps and motors above 10 KW
4	All other Electric control panels for LV distribution, DG panel, etc.
5	Instrument Control Panels for PLC Systems
6	All type of flow meters
7	Ultrasonic Level Sensor transmitter
8	All type of Pressure sensor
9	All type of Energy Meters
10	Expansion Joints
11	Air Vessels

S. No.	Equipment/Material
12	Other Surge Protection Equipment
13	Electrical Hoist
14	Switch Yard Control Panel
15	Sluice Gates
16	Chlorinators
17	Any other material, ask for inspection by the department

The Contractor shall notify Engineer-in-Charge at least 4 weeks in advance for carrying out the Pre-Dispatch inspection, and tests before the dispatch of materials. Failure to Pre-Dispatch inspection/tests, the contractor shall be liable for all costs incurred against such dispatches. No material scheduled or notified for pre-dispatch shall be accepted until inspection/have been successfully carried at manufacturers or other selected premises and the inspection report has been approved by Engineer-in-Charge and he has given consent for dispatch of material.

In addition to the pre-dispatch inspections, the Engineer-in-Charge may ask for additional certificates from manufacturer to satisfy with the quality of material used and for the compliance to respective standards.

For all materials and equipments not listed above, the contractor shall produce manufacturers test certificates for material, performance, efficiencies, workmanship and standard compliance etc. as directed by the Engineer-in-Charge, to satisfy with the quality of the material to be received.

The Engineer-in-Charge may also ask for Pre-Dispatch inspections for any other item(s) not shown in the list of items requiring pre-dispatch inspection, for which the contractor shall make necessary arrangements, without any additional costs to the Department.

Considering the less quantity of material to be got tested at manufacturer's work, the EIC may condone such pre-dispatch inspection after obtaining manufacturer's test certificates for satisfactory completion of tests for pre-dispatch as mentioned hereinafter. The Contractor shall thereafter be responsible for the equipment performance at site for given duty conditions. Pre-dispatch inspection and its approval shall also not relieve the Contractor from its responsibility of performance of material in design conditions during execution and maintenance.

14.2. **Testing And Inspection Of MS/DI Pipes & Specials**

At all the manufacturing sites Department's Representative shall be stationed to witness the manufacturing and all the tests mentioned in the Chapter for Specifications for MS Pipes. For DI pipes departments representative shall review the record of online hydrostatic test of all pipes to be supplied. He shall conduct all other tests as relevant

Standards which includes dimensional tests, ovality test, mechanical test, straightness test etc. The pipes or specials will only be dispatched after necessary certification by the Department's representative. The Engineer-in-Charge may also ask for repetition of some tests, even after successful testing by the Department's representative in his presence or in front of a third party authorized by the Department. The contractor in such cases will co-operate and provide all necessary facilities for re-testing, without any additional costs to the Department. All pipes will be tested at the factory test pressures in accordance to the relevant IS.

14.3. Inspection And Testing For Butterfly Valves

During testing there shall be no visible evidence of structural damage to any of the valve component.

a) The following test shall be carried out for butterfly valves:
    - (i) Seat leakage test at rated pressure
    - (ii) Body hydrostatic test at 1.5 times the rated pressure
    - (iii) Disc strength test at body test pressure
    - (iv) Valve operation with and without actuator
    - (v) For effort Required in manual operation of valve
    - (vi) Crack opening test under tension
    - (vii) Other tests specified in BS 5155
    - (viii) General construction features of gear box as per requirement given in Chapter 4.
b) Valves to be tested with actuators shall be tested with actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

14.4. Inspection And Testing For Sluice Valves

During testing there shall be no visible evidence of structural damage to any of the valve component. Following tests shall be carried out.

- I) Seat leakage test at rated pressure
- ii) hydrostatic test at 1.5 times the rated pressure
- iii) Valve operation with and without actuator
- iv) For effort Required in manual operation of valve
- v) Other tests specified in IS 14846
- vi) General construction features of gear box as per requirement given in Chapter 4.

Valves to be tested with actuators shall be tested with actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

Inspection And Testing For Dual Plate Check Valves

During testing there shall be no visible evidence of structural damage to any of the valve component.

- Seat leakage test at rated pressure
- Body hydrostatic test at 1.5 times rated pressure
- Other tests specified in API 598

14.5. Inspection And Testing For Air Valves

During testing there shall be no visible evidence of structural damage to any of the valve component.

- Seat leakage test at rated pressure
- Operation
- As per relevant ISS

14.6. Inspection And Testing of Pumps of more than 20 kW

The performance and hydraulic tests of the pumps shall be made with their respective duty motors and frequency drive. The following inspections/tests shall be carried out:

1	Nondestructive special test	Casing - Dye penetration test on critical area, Impeller -Dye penetration test on critical area, Shaft - Ultrasonic test,
2	Hydrostatic Test	1.5 times the shut-off head
3	Performance Test	As per IS 5120 & IS 9137 at reduced speed as approved by Engineer-in-Charge. Head v/s Discharge characteristic - Power absorbed v/s Discharge - Efficiency v/s Discharge - Readings for the above tests shall be taken at duty points.
4	Strip Test	Clearances within tolerance limits and no signs of cavitations evident.
5	Mechanical Balancing	As per IS: 11723, Gr 6.3 or better.

6	Other Tests	For Vibration levels of Shafts For noise levels
7	Visual Inspection	Pumps shall be offered for visual inspection before shipment. The pump components shall not be painted before inspection.

14.7. Inspection Of Motors

Motors over 20 kW site rating shall be subject to full performance tests, (including Power factor) which may be witnessed by the authorized person / agency of the department at the Motor manufacturer's works. Motors of 5.5 kW to 20 kW site rating shall be subject to performance tests but will not be witnessed. Motors under 5.5 kW site rating shall be subject to "type test" standards. Type test certificates that shall include the following shall be provided for all motors:

- Motor testing shall be carried out in accordance with the requirements of IS 325.
- Acceptance Tests - Full load test to determine efficiency, power factor and slip shall be conducted on all the motors. No negative tolerance shall be permitted on the tested motor efficiency
- All type test certificates conducted on similar motors.

14.8. Inspection Of LV Distribution Panel

- All routine tests on all panels.
- All type test certificate conducted on similar panels to be forwarded.

14.9. Other Equipments

All the items listed below shall be inspected before dispatch for the general requirement of testing in the standards to which they conform, the Department's requirement as given in the specifications, the general arrangements and for workmanship.

- Electro Magnetic Full Bore Meters, Turbine type meters.

14.10. Manufacture's certifications

For other items to be used for the work, the department may ask for relevant certificate of the manufacturer.

14.11. Pre use inspection

Following items may be put to inspection by the EiC or his authorized representative before the use. The inspection shall be done for sample of the material on random basis in recognized laboratory. The scope of inspection shall be determined as per relevant Indian Standards.

- PAC
- Lime
- Liquid chlorine

Chief Executive Officer

Udaipur Smart City Limited

Testing, Commissioning & Trial Run

14.12. **Inspection and test after erection**

In addition to the progressive supervision and inspection by the Engineer-in-Charge the Contractor shall offer for inspection to Engineer in Charge, the complete, erected System or its Parts on which tests are to be carried out. After such inspection by Engineer in Charge, each equipment/subsystem shall be tested by the Contractor in accordance with the applicable standards in the presence of Engineer in Charge.

It is not the intent to specify herein all details about the commissioning activities. However the commissioning checks in brief are given as guidance.

The pre-commissioning test results shall be documented for record purposes and compared with the shop test certificates.

14.13. **Test Instrumentation**

All required test instrumentation, for the performance and efficiency tests, shall be supplied by the Contractor and shall be retained by him upon satisfactory conclusion of all such tests at the site. All costs associated with the supply, calibration, installation and return of the test instrumentation shall be included in the contract price. The test instrumentation for the performance tests shall be in accordance with the code. All test instrumentation shall be as per Indian Standards as approved by the Engineer in Charge. All calibration procedures and standards shall be subject to the Engineer in Charge's approval. Batch calibration will not be accepted.

14.14. **Pipe Line**

The sectional testing of pipeline shall be done as per provisions laid in the Chapter of "Specifications for Pipes" along with the laying of pipelines. The tested pipeline will be joined by gap pieces to complete the total physical completion of works.

The laid pipeline will be joined with respective manifold through valves. Just before the commissioning the complete main will be checked for:

- All the valves in the system will be inspected for proper lubrication, manual operation.
- All air valves shall be inspected for proper fitting and operation of isolating valves.
- All flange joints will be checked for tightness of all bolts, clamps, etc.
- The entire transmission shall be checked for proper soil cover.
- The structures will be checked for any constructional defects.
- The valve chambers and their surroundings will be checked for its cleanliness.

14.15. **Mechanical**

The erection, piping and wiring of each item shall be checked as per approved drawings, vendors drawings, wiring schematics and cable terminations. If any minor modifications are noted, they shall be incorporated in the appropriate "as built" drawings.

14.16. **Pumps**

14.16.1. **Pre-commissioning Checks**

- Check name plate details
- Check tightness of all bolts, clamps, etc.
- Check alignment of the pump and motor
- Inspect the bearings visually and check that adequate lubrication has been applied.
- Confirm that the shaft is free and it is possible to easily rotate the shaft by hand.
- Check that the pump glands have been filled and tightened adequately.
- Ensure that the driver run tests have been successfully completed and the direction of rotation of the driver is proper.

14.16.2. **Pump Commissioning Checks**

- Couple the pump with the driver.
- Open the suction valve of the pump slowly and allow the pump to slowly prime. Keep the vent valve/cock open, until all air has been completely expelled and the pump is flooded with water. If required the discharge valve of the pump may be slightly opened and then closed subsequently.
- After ensuring that the pump has been primed satisfactorily, the discharge valve is closed and the suction valve is open, start the pump momentarily and stop it.
- Check if the pump is making any abnormal sound and that acceleration and deceleration of the shaft is smooth.
- If found normal, the pump can be put on an eight hour trial run. For the trial run make necessary arrangements for the discharge of the pump. During this trial run, note down regular observations regarding the discharge pressure, bearing temperature and bearing vibrations.
- Check the alignment of the pump and motor.

14.16.3. **Valves of all kind**

14.16.3.1. **Pre-commissioning Checks**

- Check dimensional details and alignment

- Check tightness of all bolts, joints, etc.
- Check manual operation; in case of motor driven valves check electrical operation
- Check for duration of full closure and opening cycles

14.16.3.2. **Commissioning Checks**

- Check operation in the starting and stop routine of the related pumps
- Check for operation from control panel
- Check for leakage of shaft glands, joints

14.17. **Electrical**

The contractor shall arrange to carry out All tests are as per IS Specification to the satisfaction of the EIC. The contractor will ensure that all works connected with the line and electrical plant have been completed correctly as per Indian Electricity Rules and procedure. Any extra cost involved due to incompleteness of work or bad workmanship found but subsequently, shall be set right forthwith by the contractor at his cost.

14.18. **Test On Motors**

14.18.1. **Pre-Commissioning Tests**

- Check that motor name plate details are as per the approved vendor drawings and factory test reports
- Check tightness of all bolts, clamps etc.
- Check that Earthing connections have been properly connected.
- Check that bearings are in a good condition and are properly lubricated.
- Open the terminal box and check that the connecting terminals are secure and the clearance between the terminals is adequate.

14.18.2. **Commissioning Tests**

- Insulation resistance test of motor windings and cables.
- Continuity check for power and control cables.
- Winding resistance measurement in case of motors rated 55 kW and above.
- Control, interlock and protection schemes.
- Operation and setting of timer, in case of Star Delta starters.
- Phase sequence and rotation.
- No load trial run for observation of vibrations, temperature of bearings etc.
- On load operation, starting and running load current (also observe vibrations & temperature).
- Operation of timer in case of star delta starters

14.18.3. **Pre- Commissioning Checks:**

- ❖ Check nameplate details according to specification.
- ❖ Check for any physical damage.
- ❖ Megger test between each core and armoured / sheet.
- ❖ Continuity check.
- ❖ Connections.

14.19. **Tests For Electrical Installations:**

14.19.1. **Pre- Commissioning Checks:**

- ❖ Check all closing, tripping, supervision and interlock of control devices.
- ❖ Check operation of all alarm circuits.
- ❖ Earthing:
  - o Measure resistance of each earth electrode by isolating the same from station grid as well as from other earth electrodes.
  - o Check continuity of grid conductors and wires.

14.19.2. **Commissioning Test:**

- ❖ Cable Testing:
  - o All cables as per rating of motor installed to be high voltage tested.
- ❖ In addition to above, any other tests specified by manufacturer shall be carried out as per manufacturer's instruction.

14.19.3. **Tests on Cables after Installation**

a) Physical checking of cable laying and termination arrangement, including checking of phase to phase and phase to earth clearances, cable tag number as per cable schedule etc.
b) Disconnect the cable at both ends and measure the insulation resistance, continuity of conductor, application of HVDC test particularly only in case of HT cables.
c) Check site results against shop test results.
d) On receipt at site all LT/HT power cables and LT cables shall be checked for quantity and size of cables, the continuity test between two ends of the drum wound cable and insulation resistance shall be measured before accepting the material. These test results shall be documented for record purposes and compared with the pre-commissioning results.

Witnessed high voltage pressure tests shall not be carried out on PVC/SWAPVC control cables, but it shall remain the responsibility of the Contractor to test the insulation of these cables both between cores and between cores and earth during installation with a 'Megger' 500 volt hand generator. The Contractor shall test all cables after installation

to ensure correct phasing out of cores, continuity of cores sheath and armoured over the whole length of the cable.

14.19.4. **Earthing System Tests**

The Contractor shall demonstrate to the Engineer that the resistance of the electrodes to earth and the earth conductor continuity is in accordance with the Specification. The tests shall be made on completion of the installation.

The test shall be performed from each major item of plant, by using an 'Earth Megger' and auxiliary return conductor.

14.20. **Electrical Installation - General**

14.20.1. **Functional Checking**

- Check all operations e.g. open/close/forward/reverse/start/stop etc. as per block logic diagram.
- Check all indication circuits.
- Check all alarm circuits.
- Check all protective devices and their settings, by primary or secondary injection method.
- Shorting and Earthing of all spare cores of any CT:

14.20.2. **Earthing System**

- Measure earth resistance of individual earth pit when isolated from other electrodes/grid.
- Check continuity of grid conductor and earth leads.
- Make soil resistivity test.
- Check the entire earth grid resistance with multiple earth electrodes.
- Check for method of connections for buried grid conductor, earth electrodes with grid, Earthing conductor at grid and Earthing conductor at equipment end.
- Check tightness of all bolts, wherever bolt type fasteners are used.

14.20.3. **Relays**

- Check for relay Tag No., make, type and supply details etc.
- Check relay circuit connections, CT core used, CT ratio and other parameters, ferrules for panel wiring etc.
- Primary or secondary current injection testing of relays for their operation such as indication/alarm/ control etc. (In case of Voltage element of relays, supply the circuit by proper voltage.)
- Insulation resistance.

- Tightness of all bolts, terminations etc.

14.20.4. **Meters**

- Check for Tag No., make, type, dial range, ferrules for panel wiring and supply details etc.
- Check wiring circuit.
- Tightness of all bolts, terminations etc.
- Insulation resistance.

14.20.5. **Lighting System**

- Check main circuit connections from Power Distribution Board to local lighting panels. Also for distribution on emergency or non-emergency bus as per approved design drawings.
- Check operation of Earth Leakage Circuit Breaker, located at local lighting panel (LP).
- Check all single phase outgoing circuits from lighting panel to lighting circuits, receptacle circuits etc., for proper wiring and Earthing connections.
- Check all receptacles are properly connected to their control switch and are properly earthed.
- Insulation resistance test on wiring of each individual circuit.

14.20.6. **Testing of cables**

Before energizing, the insulation resistance shall be measured from phase to phase and phase to ground.

14.20.7. **Loop Checking**

After completion of installation and termination, loop checking shall be done by the Contractor in the presence of the Engineer in Charge or his representative. Standard equipment and instruments, such as continuity tester, multi-meter etc. shall be arranged by the Contractor and one such set of checking equipment shall be kept spare at the site office. Contractor to arrange for standard set of tools and tool-kit bag at the time of loop checking. Loop checking reports shall be made for each individual loop checking and submitted to the Engineer in Charge and any changes shall be recorded on reference drawings.

14.20.8. **Lighting installation Testing**

Lighting installation shall be tested as per the instructions of the Engineer in Charge and shall include but not be limited to the following:

- Measure the insulation resistance of each circuit without the lamps being in place. It should be not less than 1 M ohms to earth.
- Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps. If required, load shall be re-balanced on the three phases.
- Check the earth continuity for all socket outlets. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.
- After inserting all the lamps and switching on all circuits, minimum and maximum illumination level shall be measured in the area with an approved industrial light meter. Contractor shall supply an approved luxmeter for testing at no extra cost.

14.21. **Instrumentation**

14.21.1. **Site Calibration**

Standard calibration procedures shall be used for calibrating all field instruments. All reference equipment, used for calibration, shall be certified from an authorized certifying agency, to be arranged by the Contractor at his own cost. At the time of calibration, standard calibration norms shall be adopted and the same will be documented for record purposes.

Calibration shall be performed in the presence of the Engineer in Charge or his representative. The instrumentation shall be calibrated while being commissioned. The Contractor will monitor and check the instrument calibration throughout the Operation and Maintenance period.

14.21.2. **Instrumentation Installation & Pre-commissioning Checks**

- Check the exact location of the instrument with reference to the Pipe & Instrumentation diagram and/or the General Arrangement drawing.
- Check the model No. and instrument type with reference to the technical specification requirements.
- Check all mounting and fixing arrangements and required accessories such as isolation valve, nuts & bolts, siphon etc.
- Check that the instrument installation is as per the installation drawing.
- Check the cable type, connections for power supply as well as signal cables.
- Check the loop continuity for every circuit. While this is being done, the power supply to the instrument shall be cut-off.
- Site calibration of the instruments shall be compared with the manufacturer's factory test reports.
- After switching on the instrument/system, it shall be monitored hourly and the data obtained shall be recorded and compared with the reference norms to ascertain whether any recalibration is required. If recalibration is required it shall be carried out using standard reference equipment/instruments at no extra cost.

14.21.3. **Instrumentation Commissioning**

- Each control loop and interlock shall be tested independently, in manual mode first and then in auto mode from the PLC. The operation shall be checked for conformity with the approved block logic in both modes.
- Annunciation system shall be checked as performance testing by simulating the condition and by passing in actual mode and then individual loop will be checked for annunciation system. All motorized valves shall be checked in manual mode first, from controls on the control panel and feed-back from the field for valve on/off shall be checked on the mimic and panel. All pump control ON/OFF shall be checked in manual mode first.

14.21.4. **Tests for Water tightness of Water-retaining structures**

The contractor shall carry out a water tightness test as per IS: 3370 for the maximum water head condition i.e. with the water standing at full supply level. All cost of testing shall be borne by the contractor. This test shall be carried out in accordance with the procedure given below

- For water tightness test, before the filling operations are started, the reservoirs shall be jointly inspected by the Engineer in Charge and the representative of the Contractor and condition of surfaces of wall, construction joints etc. shall be inspected and noted and it shall be ensured that jointing material filled in the joints is in position and all openings are closed. The contractor shall make necessary arrangement for ventilation and lighting of reservoir by way of flood lights, circulators etc. for carrying out proper inspection of surfaces and internal conditions if so desired by the Engineer in Charge.
- The water retaining structures shall be filled with water gradually at the rate not exceeding 30 cm. rise in water level per hour and shall extend for a period of 72 hours. Records of leakages starting at different level of water in the reservoirs, if any, shall be kept.
- The reservoirs once filled shall be allowed to remain filled for a period of 7 days before any readings or drop in water level is recorded again at 7 days. The total drop in surface level over a period of 7 days shall be taken as indication of the water tightness of the reservoir, which for all practical purposes shall not exceed 40mm. There shall be no indication of leakages around the puddle collars or on the wall and bottom of the reservoir.
- If the structure does not satisfy the test requirements, and the daily drop in water level is decreasing, the period of test may be extended for further seven days and if the specified limit is not exceeded, the structure may be considered as satisfactory.

- In case the drop in water level exceeds the permissible limit with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer in charge to reduce the leakage in the permissible limit. The entire rectification work that shall be carried out in this connection shall be at Contractor's cost.

- If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the water retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure will be condemned and the Contractor will dismantle and reconstruct the structure, to the original specification, at his own cost.

14.22. **Documentation**

Set of documents shall be prepared and maintained by the Contractor and one set of the latest revised documents shall always be kept at site. The following documents shall be prepared by the Contractor:

- Data sheets for instrument specification and selection
- Instrument Schedule
- Instrumentation schedule
- Instrumentation cable schedule
- Loop drawings for instruments in the field and control panel
- Instrument test and calibration report
- Instrument installation drawings
- As built drawings and G.A. Drawings for equipment and instrument installation

The Contractor shall keep on site, two sets of the latest revised Operation, Maintenance and Calibration manuals for all field instruments and sub systems, annunciation system, data loggers, indicating controllers and PLC system etc.

14.23. **Performance Tests at Site**

14.23.1. **Execution of the tests**

As soon as possible after the equipment has been installed and after physical completion of the work, performance tests shall be carried out as per relevant test requirements and mutually agreed/specified Codes and Standards. These tests may repeat the tests carried out at the manufacturer's works and/or his sub-vendor/sub-contractor's works and any other tests the Engineer in Charge may require in order to determinate that the equipment and works are in accordance with the specifications and guarantees.

Performance tests for individual items of Equipment, shall be conducted on all equipment supplied by the Contractor.

A program for conducting the performance tests shall be submitted to the Engineer in Charge, for approval, at least fourteen days before the commencement of the tests.

If the Contractor so desires, the equipment may be run for a reasonable time, immediately before the performance test is conducted. A request for this run, stating

duration and operating point must be made, in writing to the Engineer in Charge at least three days before the performance test.

During the period of any test, the conditions shall be held as steady as possible, compatible with safe and effective operation.

The power consumption of all continuously running auxiliary equipment shall also be measured and recorded during the performance tests.

After the results of the performance tests have been submitted to and approved by the Engineer in Charge, a summary of the test readings and the performance calculations shall be incorporated in the final version of the Operating and Maintenance Instruction Manuals.

14.23.2. **Rejection of the system or system components**

If the performance tests indicate the computed values of performance parameters have deviated from the guaranteed values and the Contractor is unable, within 21 days or such extension of time as may be allowed by the Engineer in Charge, to remedy such deficiency, then the Engineer-in-Charge shall have the right to reject the component or the system.

14.24. **Commissioning**

14.24.1. **General**

After successful checks and after erection and pre-commissioning tests, the entire system shall be commissioned by the Contractor.

During commissioning, the Contractor shall supply all material and labour to supervise, operate, keep in operation, adjust, test, service, repair and do all things necessary to keep the System running to the satisfaction of the Engineer in Charge. This shall include labour on a 24 hour-a-day basis during the test period and for such other period of continuous operation, as the Engineer in Charge may consider necessary to establish the efficient operation of the System.

If any test results/operations show noticeable variation from the Specification requirements for the System or any particular item of the System, the Contractor shall immediately take steps to rectify the deficiency without any extra cost to Department.

14.24.2. **System Commissioning**

The Contractor shall be responsible for trial runs, testing and commissioning of the entire system under design and operating conditions or under conditions which the Engineer in Charge may define and which in no case shall exceed the design and operational conditions. The System commissioning shall commence after the work has been physically completed to the satisfaction of the Engineer in Charge. The design and operation conditions are as follows:

- Design capacity of the pumps

- Starting of pumps against closed/ open valves
- Stopping of pumps after closure/ opening of delivery header valves
- Power cut and sudden stop of all pumps under design flow conditions
- Closing of the line valves against full static pressure
- Operation of all valves (manual and motorized/ manual)
- Operation of all air valves
- Operation of Air vessel if any
- Operation of all measuring instruments

The timing of the commissioning tests will depend on the availability of water and power.

The Contractor shall prepare the entire system for the execution of the tests complete with all required taps, branches with blank flanges, etc. All these provisions have to be of a durable nature so that the tests can be repeated even after several years. He has to provide all the equipment for the execution of the tests and for the measuring and recording of:

- pressure at various points within the pump station and the pipeline, precision 1 m (0.1 bar)
- head losses across different valves and fittings
- overall energy efficiency of the pumping system at the prescribed flow rates
- performance of the non-return valves
- other tests required for the verification of the performance data of the pump station system in conjunction with the pipeline system
- Loss of water in mains

The Contractor may engage an institution for the execution of the required tests and their monitoring at his own cost. The institution has to be approved by the Engineer in Charge.

The system shall be treated as commissioned only when the entire system has been successfully operated over a period of time as follows:

- 36 hours uninterrupted, continuous running for three days, at design flow/ flow noticed by Engineer-in-Charge. or
- Short duration operation of 8 hours with a 8 hour stop and a further 4 hours pumping totaling 12 hours working per day for a three day period, at design flow/ flow noticed by Engineer-in-Charge. or

Any repairs or replacement required during this period shall be done by the Contractor at his own cost.

The Contractor shall allow for commissioning to be conducted at any time during the O &M Period without extra charges under the Contract.

The operation of the system solely for the purpose of maintaining partial supply by or on behalf of the Department shall not be taken as evidence that any work has fulfilled the

commissioning tests, or has been taken over unless the Engineer in Charge specifically states so in writing.

14.25. **Trial Runs**

The Contractor shall run and maintain the System for 30 days at a stretch, or any other stipulated periods and conditions prescribed by the Engineer-in-Charge, from the date of commissioning. During the trial run all components of the system must function in a synchronized manner so as to give all desired outputs at efficiencies guaranteed or as stipulated in the specifications, failing which the Engineer-in-Charge may extend the period of trial run, till a date the entire system functions to the complete satisfaction of Engineer-in-Charge.

Standard test reports shall be compiled at all stages of installation, pre-commissioning and commissioning. Any modifications or changes shall be incorporated and marked on the respective reference drawings and the Engineer in Charge shall be advised.

The necessary protocol must be maintained for record purposes, jointly with Engineer in Charge and/or the authorized Representative of the Department.

14.26. **Performance during Operation and Maintenance period**

The Department reserves the right to carry out further tests to check the performance and efficiency of the Plant at the end of the O&M period. Such adjustments to the plant, as may be considered part of normal operating routine, shall be carried out prior to these tests.

Should the results of such repeat tests, carried out by the Department, indicate that performance values deviate from guaranteed values or the auxiliary power consumption exceeds 1.0% of guaranteed value, then the Contractor shall be given the opportunity to take corrective measures and carry out further tests, all at his own expense. Should the test indicate performance and auxiliary power consumption values below the guaranteed value then the Contractor's security deposit may be forfeited.

Chief Executive Officer
Udaipur Smart City Limited

Chapter 15. Operation &Maintenance

15.1. General

This section of specifications applies to the specifications of materials used for operation and maintenance, the workmanship, period for routine maintenance, specifications for the acceptable quality of treated water, maintenance of records, and responsibilities during operation and maintenance period.

The Contractor shall operate and maintain the entire system all buildings constructed in the project as per the scope of work, campus areas for the entire period specified in the Contract.

15.2. Specifications

The specification of materials used for repairs shall be the one used in the original work. If not used during execution, specifications for such materials, which were not used during construction, shall be got approved by the department, prior to commencement of operation and maintenance period and must be incorporated in the O&M manual. Without being limited by this clause, during O&M period, the contractor shall use appropriate material for repairs even if the material required for such repair is not approved earlier, and no delay in repairs shall be subjected to such limitation. But subsequent to such use of material, the contractor shall submit proposals for the approval of the specifications of such material. The submissions and approval of material shall be done in accordance to the conditions laid down in the special conditions of contract. The approved material, will subsequently form a part of the O&M manual.

15.3. Experience and Qualification of Staff

For all operation and maintenance works, the contractor shall provide required skilled staff, who have adequate qualifications and sufficient experience of similar works. The minimum qualifications and experience required for minimum staff to be deployed by the contractor shall be as per scope of work for carrying out the O&M functions.

15.4. **Lubrication**

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor, in the operation and maintenance manuals. The number of types of lubricants shall be kept to a minimum. In case of grease lubricated bearings for electric motors, a lithium base grease is preferred.

The Contractor shall indicate the brand name of indigenously available equivalent lubricants with complete duty specification, in the O&M manual. The Contractor shall also furnish the schedule of quantities for each fill, frequency of filling and annual requirement in O&M manual.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose means more than once in a month.

Where more than one type of special grease is required, a grease gun for each special type shall be used.

All lubricant systems shall be designed so as not to cause a fire or pollution hazard.

The Contractor shall supply flushing oil for such lubrication system when an item of plant is ready for preliminary running.

15.5. **Spare Parts**

All spare parts used for the equipment in the maintenance of the system must be from the manufacturer of the equipment or if the equipment itself has been made with parts of other manufacturer the parts must be of the same make as used in the equipment supplied and installed.

All spare parts shall be packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be labeled on the outside of its packing with its description, number and purpose and, if more than one spare is packed in a single case, a general description of the case contents shall be shown on the outside and a packing list enclosed.

15.6. **Particular Requirements during O&M**

The workmanship observed for all repair and maintenance work must be in accordance to "Good Engineering Practices". All activities during O&M should be monitored and recorded and this should be accessible to all concerned departmental persons from anywhere at any time.

15.7. **Pipeline**

The MS clamps, pipe sections used must have thickness as per design requirement at the point of installation and shall be coated internally and externally as specified for MS pipes in the chapter of "Specifications for Pipes".

The rubber gaskets/rings, nut & bolts etc. to be used shall be as per specifications given for respective items in the Chapters of "Specifications for Pipes" and "Specifications for Valves".

After each repair the damaged coating of pipes must be repaired and if in trench conditions, the trench must be filled with approved soil so as to provide minimum cover of 0.90 meters.

Stretches along pipe alignments where cover is washed out or removed due to other reasons must be rehabilitated so that the minimum cover required is always maintained.

All cracks in pipe supporting structures, valve chambers and their edges must be racked, filled and made good with cement sand mortar 1:2.

15.8. **Operations and Maintenance Manual**

The comprehensive manual to be submitted before the operation and maintenance period, i.e. during execution stage as defined in special conditions, of contract containing the contents as specified in Chapter – 2 of "scope of work" given in Volume II of bid document, must be updated, not limited to, on principals listed below:

1) Up-dating any changes in the procedures existing in the O&M manual, deemed necessary to be changed due to limitation observed during the maintenance period and incorporating the procedures for maintenance of other repairs/break downs not incorporated in the maintenance but faced during O&M period.
2) Procedures for repair of leaks/burst in different types of pipes must be provided, with supporting drawings as provided in the O&M manual must be updated if any differences are observed during O&M contract.
3) Frequency of spares used in maintenance of valves (air-valve, sluice valves and butterfly valves), expansion joints, equipment installed for surge protection and protection against corrosion must be recorded for updating the contents of manual.
4) Record of trouble shooting points and details of events causing troubles (break down's) during maintenance of pumps / motors / measuring equipment(s), / electric

panel and accessories there in must be maintained and used for updating the contents of manual.

5) The record of Inventory used must be maintained and the relevant portion of O&M manual must be updated to list out the requirement of Inventory for maintaining the system for 12 months.
6) The provisions in the manual must incorporate every aspect of good industrial practices even if not elaborated here or in other parts of the bid documents. The provisions in the approved operation and maintenance document shall only be valid and binding for both the parties during operation and maintenance along with the additions and deletions made.
7) The manual so prepared must be updated after the end of every year of operation and maintenance, giving effect to the experience gained and the observations made by the Department during the maintenance period.
8) Under the contract all chemicals including liquid chlorine for pre-chlorination & post chlorination, PAC, Lime etc. required to treat raw water shall be supplied by the contractor and used to achieve the required quality. The quantity of chemicals to be used will be assessed by the contractor on the basis of quality of raw water which varies from month to month. Contractor may be directed to use additional quantity of chlorination in case of some incidental demand arising due to unforeseen health hazards)

15.9. **Scheduled and Preventive Maintenance of the system**

Scheduled and Preventive Maintenance of the various components and the entire system should be done as per provisions of the O&M Water Supply Manual of CPHEEO. The contractor will prepare a matrix specific to this contract and will make it part of the O&M Manual.

The schedule for next month should be provided to the Engineer In charge on 15th of the previous month and all Scheduled and Preventive Maintenance work should be done during the month accordingly. The monthly report of each month should invariably form part of the monthly bill.

The details of scheduled dates of preventive maintenance of all material and equipment and details of preventive maintenance done should be recorded and this should be accessible to all concerned departmental persons from anywhere at any time.

Under the contract all chemicals including liquid chlorine for pre-chlorination & post chlorination, PAC, Lime etc. required to treat raw water shall be supplied by the department. Contractor may be directed to use additional quantity of chlorination in case of some incidental demand arising due to unforeseen health hazards)

The contractor Will-

1. maintain and replace materials for assets and equipments executed under current contractonly.

2. Keep close watch on the leakages to reduce NRW at the end of 2nd year of O&M(including 1st year of DLP) and will bring down 10% where complete new distribution system has been laied and to 20 % where partial distribution system has been laid under the contract. Failing which penalty will be imposed on the contractor.
3. Identify and take immediate suitable steps for their disconnection, in consultation with department.
4. Repair all leakages same day of occurance/reporting.
5. Repair the defunct meters.
6. Make new house connections by installation of meter, pipe and other required material, as per instruction of the department. The payment to the contractor for these new connections will be made as per items and rates as were approved in the original order. How ever a escalation amount of 5 % will be paid after DLP of 1 year. The consumer may also opt to procure his own meter having specifications similar to those installed by the contractor under current contract.

The department may appoint other agency for of meter reading, mapping of consumers, consumer complaint redressel, etc through IMIS . The contractor will assist and provide all required support, data input, documents, information to the other agency. The requirement and actual activities done by the contractor for periodic and preventive maintainance of the system, equipments and instrumentation will also be made in the IMIS by the contractor.

Chief Executive Officer
Udaipur Smart City Limited

SECTION V-B (SEWERAGE WORKS)

1. PART-I SCOPE OF WORK

1.1 OBJECTIVES

The Area based development (ABD) envisions retrofitting and redeveloping sewerage system of the "Walled City Area" also referred as Project area, as most of the sewerage network in Walled City Area has outlived its life and become dysfunctional and leaking, thus, causing pollution in the lake Pichola and leading to unhygienic conditions in the project area.

Not complete Walled City Area has been covered by the sewerage network and wherever the ground situation warrants new sewer shall be laid using Trenchless Technology so as to cause minimum inconvenience to the local residents. Wherever the situation and site conditions permit new sewers shall be laid by Open cut excavation also. The contractor shall submit his proposal in the form of SIP to the Employer for approval clearly stating that which areas are suitable for Trenchless laying and which are for Open cut excavation.

The components of redeveloped sewerage system shall include the following:

1. Sewerage Network length of about 84 Kms
2. 100% House Service Connections (Approximately 19,300 Houses shall be covered)
3. Ultrasonic Water level Sensors for detecting overflows in manholes.
4. SCADA system for automation of the pumps installed in the LS and MWPS.

Services under this contract have been bifurcated into three parts to facilitate easy understanding of the scope and for better planning and execution of the project. The bidder has to include in his offer the entire scope of services needed for achieving the objectives and intentions of the project and the program.

- ✓ Service Improvement Plan (SIP) Preparation (Survey, Investigation, Methodology for project execution, Design Submissions, approval, etc).
- ✓ Design & Build (Design, Construction and commissioning of the project components including continual designs submissions and approval as per the project methodology approved during SIP preparation)
- ✓ Operating & Maintenance of created assets for 10 years after the successful commissioning of the project. The first year of the O&M period shall be the defect liability period.

1.2 EXISTING SEWERAGE SYSTEM IN THE WALLED CITY / PROJECT AREA

The walled city area has a very old sewerage system and is in worn out condition due to completion of its design life.

Initially PHED (Public Health Engineering Department) introduced the Sewerage System in the city and they constructed sewerage network for 84.2 Ha area in the Walled City in the year 1976-78. The total length of the network is 21.5 km and has approximately 5,000 house service connections. The colonies or areas served by the PHED scheme are listed below: Chand Pol Area, Shivaji Nagar, Ganesh Ghati, Shakti Nagar, Bhupal Wadi, Ashok Nagar, Delhi Gate, Subhash Nagar, Hathi Pol, Hiran Magri Sector-3. The trunk sewer of this sewerage system starts at Suraj Pol and drains into River Ahar at Manwakheda. The size of pipes in the sewerage system ranges from 150 mm to 300 mm and the size of the trunk main ranges from 400 mm to 800 mm.This system is in highly degraded condition, therefore whole area has been proposed for new sewer line.

The Udaipur Improvement Trust (UIT) built sewerage system of 23.5 kms length for the areas around the lakes in the year 2002-04, to avoid untreated sewage being discharged into the lakes. The sewerage network built under this scheme covers peripheral areas of lake Pichola as well as internal areas like Delhi Gate, Chandpole, etc. Approximately 6,000 house service connections are provided through this system. The size of sewer is 150 mm only and therefore frequent overflows are observed in the UIT area. Main areas covered by the above scheme are as follows: Hari Das Ji Ki Magri, Ambamata, Malla Tallai, Brahm Pol Area, Amber

Mata, Brahm Pol Magri, Amber Garh, Left side area of Rang Sagar lake, Guni Dayal Marg Naga Magri. UIT constructed this sewerage system in two phases. In first phase, it covered an area of 144 Ha around the lakes, which includes the colonies like Ambamataa, Chandpole, City Palace area, Fateh Palace area, etc. In the second phase UIT covered an area of 212 Ha which includes the colonies like Alla Thalai, Ekalavya colony, Raza colony, Amar Nagar, Kaimi Ekta Nagar,Pragati Nagar etc.

The entire sewage generated from the walled city area finds its way to Ayad River through 800 mm diameter outfall sewer at Manwa Kheda village.

The major part of the exisitng sewerage system malfunctions at frequent rate and leads to backflows and overflows on the roads. With the passage of time many households have constructed Toilets in the extended portion of their houses and are disposing the sewage in the roadside storm water drains leading to very unhealthy conditions in the project area. The project area has extensive network of surface roadside storm drains and they ultimately discharge into the lake and causing pollution in the lake.

Sewers laid by PHED are more than 30 years old therefore they have completed the design life, hence complete old system has been proposed to be replaced with new system. In UIT area which has been laid in 2005 has not covered the complete area. The size of sewer is 150 mm, therefore facing the frequent over flow problem. Out of total line of 23.5 km in UIT area, 15.52 km is 150 mm sewer; therefore it has been proposed to replace these pipes with 200 m dia. The remaining sewer pipes in UIT area i.e., having diameters 200 mm and above shall be retained as it is and will be integrated with the design of the proposed sewerage system for the walled city area / project area.

1.3 PROPOSAL OF THE EMPLOYER

With the above objective in view, a proposal for improving the sewage collection system has been developed and is briefly described below and shall form part of the contractor's scope of services.

Sewage collection system design (indicative only and contractor shall verify the same with respect to its hydraulics and site conditions and suggest modifications accordingly) has been prepared and annexed with this RFP. The layout pattern and zoning of sewerage system design is guided by:

- Topography and existing important physical feature.
- Existing Drainage Pattern and availability of land for Lift station / SPS and other appurtenances.
- Existing and proposed layout with regard to right of way, width of road, traffic densities of roads and streets.

For designing the sewerage system, the Walled City area has been divided into various sewerage zones (five zones) and these are numbered as 10, 23, 24, 26 and 27. The ward numbers covered under these five sewerage zones are 5, 9, 10, 11, 12, 13, 14, 15, 41, 42, 43, 44, 45, 46, 47, 48, 49 and 52 i.e., in all 17 wards are covered.

The project design year has been kept as year 2048. The present population in the Walled City (year 2016) is about 111,892 inhabitants and the projected population for the year 2048 is estimated in 170,000 inhabitants.

Under this project, the replacement in the Walled City Area of 83,5 km of sewer line of diameter 200 mm to 800 mm shall be done, which will involve road closure for some period and inevitable inconvenience to the local population. The estimated details of diameter and corresponding length of sewers is as indicated below.

Diameter (mm)	Proposed Length (m)
200	77,528
250	2,244
300	1,462
400	917
500	1,155
800	152
Total Length	**83,458**

Sewer Diameter (mm)	Number of Manholes proposed in various Sewerage Zones of the Walled City Area					
	Zone-10	Zone-23	Zone-24	Zone-26	Zone-27	TOTAL
200	473	1,590	1,850	919	405	**5,237**
250	20	33	57	44	-	**154**
300	66	7	-	-	1	**74**
350	16	5	6	-	-	**27**
400	-	-	19	-	-	**19**
500	8	-	50	-	-	**58**
800	-	-	3	-	-	**3**
Total	**583**	**1,635**	**1,985**	**963**	**406**	**5,572**

The rehabilitation and up-gradation of existing sewers, as mentioned below in the Table, is proposed using "Pipe bursting technology" and "CIPP lining".

Dia	Existing Length	Proposed Length
150mm	37690	0
200mm	7269	42756
250mm	552	2203
300mm	0	552
Total Length	**45511 Mtr**	**45511 Mtr**
	45.51 Km	**45.51 Km**

The new sewer lines are to be constructed using Trenchless Technology / Open cut excavation and details of these are given below.

Dia (mm)	Length (m)
200	34772
250	41
300	910
400	917
500	15
800	152
Total length	**37947**
	37.95 Km

The type of construction (open cut or trenchless) shall depend upon the site conditions like road width, busy junctions, market places, etc. The construction type can be a mix of trenchless and open cut excavation and as per the direction of EIC. The contractor shall be paid as per the quoted unit rates.

Approximately 19,300 house sewer connections are to be made under the project using u-PVC pipes and by construction of road side inspection chambers.

1.4 SCOPE OF WORK DURING DESIGN BUILD PHASE

The Scope of Services shall include all technical, managerial, administrative, commercial, environmental, and social interventions as required in accordance with acceptable, prudent waste water utility construction and management practices. The Scope of Services mentioned here, above and below are indicative only and the contractor is required to undertake his own detailed investigation of the Project Facilities to determine the complete Scope of Services for achieving the Minimum specified Service Levels.

The Sewerage Network to be Designed, Built, refurbished, operated and maintained, as detailed in the ITB sections, Tested and Commissioned by the Contractor shall comply with the guidelines contained in

"Manuals on Sewerage and Sewage Treatment" published by the Central Public Health & Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India.

Quantities indicated in the RFP are indicative and need to be confirmed by Contractor through SIP, and all components covered under the contract for implementation of SIP are to be planned in detail including commissioning and operation and maintenance.

The contractors scope of work includes but not limited to the following only:

1. The contractor is wholly and solely responsible for designing, providing, laying, jointing, testing, commissioning and Operation & Maintenance of the complete sewer network and other associated works to the entire satisfaction of the Employer.
2. Rehabilitation, replacement, new sewer laying, testing and commissioning of existing sewer network in walled city area of Udaipur as directed by engineer in charge including Installation of adequate number of pumping system to bypass the sewage, Leak proof arrangement on upstream and down steam side of working length by providing and laying temporary rising mains, de-silting of existing sewer line including safe disposal of silt as direct by engineer in charge. Subsequently Pre and post CCTV survey with pan and tilted colour camera shall be carried out. Designing, manufacture, fabrication, erection, etc of rehabilitation equipment and materials for proposed pipe that to be installed, dewatering, washing with clear water/suitable chemical, preparation of surface including dismantling of plaster, etc and repair of joints of pipes wherever necessary as per standard specification. Grouting with filling material, jointing material, resin material or any other suitable material including testing etc as per international/national (where similar work has been done) accepted standard regarding the sewer by confined space excavation (confined space excavation, if any required under exceptional conditions, only with prior permission of engineer in charge) in view of safety of adjacent structure/ dwelling units, wherever required maintenance of proper gradient. grouting with adequate injection pressure including repair/plastering/construction of Pre-Cast RCC manholes along with P/F PVC foot rests and AA class loading SFRC manhole cover and frames and as per relevant IS specification inclusive of supply of material, labour, Tools & plant, temporary power connection with stand by generator sets of required capacity.gas detector, reinstatement of road as original condition, forced air ventilators, etc & provision of safety equipment as per guide line of IS 11972(1987)/international standard/ relevant Indian standard, traffic control arrangement, proper lighting at night, barricading display of signboard, insurance of workmen and cleaning of site including disposal of surplus earth/malba within municipal limits. Making/replacement of existing/new property connection etc complete, including removal of all hindrance/obstruction, unforeseen item, permission from other department (depart will only assist in getting the permission) nothing extra shall be paid as directed by engineer in charge. including identification and restoration of all types existing utilities as per the concerned department norms and as per the direction of engineer in charge. The RCC work shall be done with 1: 1.5: 3 ratio of cement graded stone aggregate. Necessary cement plastering shall be done with 20 mm thick plaster in CM. 1:1 wherever required. The C.I. / PVC Sheathed footsteps shall be provided. All temporary lighting for night working shall be provided.
    i. The work proposed has been surveyed and BOQ prepared accordingly, actual quantities, location, alignment and size of pipes shall be paid as per actual site conditions and outcome of the hydraulic modeling/design done from CCTV survey data and same shall be vetted by IIT/NIT or any approved agency and as per direction of engineer in charge (EIC).
    ii. Review of Employer's proposal, undertake field surveys, verify the actual levels with the levels used in the Employer's proposal, verify the designs in the Employer's proposal, re-design and simulation of the proposed sewerage system using SEWERGEMS / SEWERCAD software or equivalent acceptable to the EIC, pumping system, etc, and prepare revised drawings, submit the revised proposal (design and drawings) and obtain EIC approval.
    iii. The scope of work includes providing, laying, jointing, testing and commissioning of sewer pipeline for laterals, branch, Trunk mains and other sewers as per the approved design and drawings. The pipe material shall depend upon the site conditions and type of technology used for constructing the sewers. The preferred pipe material is RCC NP4, DWC and HDPE.

iv. Conducting Survey for laying of sewers for proposed alignment and levels, at every 30 meters interval or as deemed appropriate and other necessary locations before execution of the work including all data required for generating L section. Submission of survey drawings showing L-Sections, ground levels at appropriate interval and other necessary locations, detailed strip plans showing adjacent structures etc., in AutoCAD for approval of the Employer's representative before execution of the work.

v. Earth work excavation for pipeline trenches and manhole chambers including depositing on bank including, danger lighting and using sight rails and boning rods at appropriate intervals and wherever necessary, including shoring, strutting, bailing out water, as directed with all lifts etc., complete & lead as per Bill of quantities for different strata and depth ranges.

vi. Providing erecting and removing three tier Barricading firmly including cost and conveyance of all materials, labour, lead and lift charges complete.

vii. Construction of all appurtenant structures such as RCC Cast in-situ / Precast manhole structures having house sewer connection and other structures coming in contact with sewage, using SRC (sulphate resisting cement confirming to IS 12330 with latest revisions) with SFRC frames & covers, ferro cement/plastic encapsulated M.S. footsteps, drop manholes, pipe supports, drain and road crossings, etc. as per Bill of Quantities, approved drawings and relevant IS codes including all temporary works and safety measures.

viii. Interlinking the existing sewer lines with proposed lines and vice versa.

ix. Providing, laying, jointing and testing of u-PVC pipes for House Service Connections for collection of sewage from each house to the street manhole as per specifications and approved drawings and as directed by the Employer's representative etc. including all materials such as connecting pipes, earthwork, pipe line laying and jointing, bedding etc. complete as per Bill of Quantities items of work.

x. Backfilling the trenches in layers of specified thickness, material as per detailed specifications of Civil Works of Rajasthan PWD/RUIDP/CPWD specifications.

xi. Rehabilitation of existing sewers through "Pipe Bursting Technology" and "CIPP Lining Technology" as per the Bill of quantities and approved SIP.

xii. Laying of new sewers using appropriate Trenchless technology method or by Open cut excavation as approved in the SIP.

xiii. Taking all measures for complying with the Environmental Management Plan and monitoring the same as per detailed specifications.

xiv. Contractor shall be responsible for providing insurance as provided in Contract data.

xv. Testing and commissioning the sewers after laying and construction of manholes as per detailed specifications.

xvi. Submission of As Built Drawings of sewer lines & its appurtenances, including L-sections and plans as per specifications including existing laterals for which the Contractor has conducted the existing system level survey showing the entire sewer network in the scope of this contract. The scope also covers associated civil works including protective works, encasing of pipes with concrete and RCC NP4 / DI and HDPE PE/ HDPE DWC, PVC pipes at road crossings, all safety measures etc.

xvii. Since the work pertains to replacement/rehabilitation of old sewer network in majority, which was laid before 30 years and some of it was laid in state times, hence it is likely that there may be variation in diameter/length/shape/alignment of existing pipes/channels from the standards sections as prevalent these days. It is suggested to the contractor to take into account such variations, which shall be clear only after de-silting and CCTV survey. Although the work is for replacement and rehabilitation, however contractor is required to consider the option of new alignment. In case it is found that it is more appropriate then replacement and rehabilitation mentioned. In such conditions confined space excavation/any appropriate changes may be permitted by EIC.

xviii. After de-silting, the final sewer measurement and the invert level shall be taken and compiled in a spread sheet or in any acceptable format and shall be submitted to EIC. This data shall be used for designing of the suitable rehabilitation method as per direction of EIC. The sewer diameter shall be measured at an interval of every 10 m. At each point the diameter of the sewer shall be measured by four different circumference points at an interval of 45° angle. The Invert level shall be measured at each manhole. It shall be ensured that the work place shall be kept tidy and dispose of any waste material on a regular day-to- day basis and all road signs and barriers shall be provided and maintained. It shall be ensured that the structural stability of the rehabilitate sewer for at least another 50 years. The contractor is fully responsible for carrying out the work including commissioning of the system with respect to technical feasibility and as per relevant IS/BIS/international standards/ ASTM Standard / WRC's SRM. Replacement of Settled Sewers: After survey of sewers and if sections of the existing sewer are found to have settled (reverse gradients) these sections shall be informed to EIC. If so instructed by the EIC, the settled sewer shall be replaced using narrow trench excavation techniques or trench less method. Replacement includes demolishing and evacuation of the existing sewer, laying sewer of and lining through the laid sewer.

xix. Contractor will submit to the EIC for approval, calculations to show that the sheet piles, walling and props selected for use in the works are of the correct size and thickness, considering the depth of excavation, soil type and adjacent superimposed loads. Narrow trench excavation to expose and remove the existing settled sewer, Contractor will undertake a soil investigation to establish the strength of the trench formation for each settled sewer length. Where the sewer has severe deformation or joint displacement, and lining is not possible without excessive loss of flow capacity, the pipe section shall be replaced by confined space excavation. This shall be limited to the immediate area required to safely remove the section of affected sewer, using sheet piling and dewatering if required. The bedding shall be prepared with concrete raft slab between the remaining pipe ends. The entire length of this section shall be rehabilitated from manhole to manhole, including the exposed area where the affected pipe shall be moved and the pipe shall be installed. In this way, the replaced pipe and rehabilitated pipe are compatible and continuous, as they are in fact the same pipe. The back filling and surface reinstatement can then be completed in the normal manner.

xx. The piled sheet below the earth surface shall be left as it is without removing.

xxi. Procedure for confined space excavation and rehabilitation of sewers in settled area as follows.

- After de-silting & sewer cleaning during the CCTV survey it will be known where the sewer is settled or the deflection / deformation is more or how the size, alignment and depth of existing sewers is different from that provided in the drawing. After getting approval from EIC confined space excavation and rectification at that location shall be done and no extra payment shall be made for the same.
- Marking the area where confined space excavation and sheet piling / other approved methods to the required depth are required to be carried out.
- Settled / damaged existing sewer pipeline shall be removed.
- Necessary bedding shall be prepared for laying the Pipes.
- The opened area shall be backfilled with approved backfill material as per the IS standards and consolidated.
- The rehabilitation shall be carried out from one manhole to another manhole including the settled area where new pipe is placed.
- All necessary safety precautions shall be taken.

xxii. Soil investigation to establish the strength formation of length shall be conducted. If the soil strength is adequate, results of the geo-technical analysis and the calculated maximum

permissible bearing pressure of the soil shall be submitted to the EIC for approval prior to the laying of replacement pipe. Wherever the safe bearing pressure of the soil is not adequate, contractor will propose alternative method such that the backfill load can be adequately accommodated. It will follow any one of the remedial measures after getting approval from the Engineer.

xxiii. Ultrasonic Water Level sensors and accessories at some manholes.

xxiv. SCADA system and associated equipments and arrangement for automation of all the LS & MWPS.

xxv. All associated works like creating diversions and bypass arrangements for the flowing sewage while the sewer construction and rehabilitation is in progress.

xxvi. The contractor shall submit the methodology clearly mentioning the sub-areas and the order / sequence in which the sewer laying shall progress in these sub-areas. The contractors aim should be to lay the sewers in those areas on priority basis which can be commissioned early and are not affected by the sewer laying process in other part of the project area. The sewer laying approach should be from downstream to upstream i.e., main sewer works shall be taken up first, then branch sewers and finally laterals shall be connected.

xxvii. It is recognized that the local residents will be put to inconvenience when the work will be taken up. It is however, also the objective of the contract to ensure minimum dislocation of the traffic and access to individual homes. It will be of utmost importance to implement the work so as to achieve the same.

xxviii. In order to achieve the above, measures like planning alternative routes for traffic, removing the excavated soil from site while work is progress and to store it in suitable location and bringing it back for refilling, proper barricading, lighting of the excavated sites during nights, etc in minimum time shall be carried out by the contractor and no extra payment shall be made to the contractor on this account.

xxix. All works pertaining to unforeseen subsurface conditions shall be executed by the Contractor at his own except for those works for which payment is admissible in other clauses and BOQ.

xxx. Testing and commissioning of the entire sewerage system constructed by the contractor.

xxxi. Operation and Maintenance of the constructed system for 10 years after commissioning of the system including one year defect liability period. The annual/yearly O & M charges shall be fixed and include all expenditures and expenses required to be incurred on labour, repair and/or replacement of material, preventive and / or breakdown maintenance including cost of any new material, equipment or machinery, equipment, consumable items, chemicals, fuel, water and all other matters and things of what so ever nature essential and desirable to run the system satisfactorily (the O&M charges do not include power charges which shall be paid by the department/line agency).

xxxii. All the testing on pipes and other material and appurtenances, at factory and site, as per the applicable standards and contractors Quality Assurance and Quality Control Plan shall be carried out in the presence of EIC or its representative.

xxxiii. All defective work and material shall be rejected and to be demolished and removed from site at the contractors cost and risk.

3. All works shall be done as per the specifications, in Bill of Quantities and in compliance to the Technical specifications and as directed by the EIC. The work shall be executed on item rate basis. Indicative Drawings related to the works to be done, are given for guidance of the Contractor. For the execution of Works, exact details will be given in construction drawings based on the alignment drawings given by the Contractor. The prospective bidder is expected to visit the site of works at his own expense to fully study the local conditions and to familiarize with the working area and local conditions and include all such factors in his quoted rates.
4. For laying of pipe line and construction of any component of project the cost of shifting of electrical poles, transformers, telephone line, trees etc., if required shall be borne by the contractor.

5. The prospective bidder is expected to visit the site of works at his own expense to fully study the local conditions and to familiarize with the working area and local conditions and include all such factors in his quoted rates.
6. The contractor shall submit geo-referenced AUTOCAD/ Shape files drawings compatible with GIS software, for the complete proposed and existing components of Sewerage Network under this contract. Location of all valves and Tees, bends, junctions and points of change in alignment of pipeline shall be determined using differential GPS of 0.5 m accuracy or better. Attributes of pipeline, like diameter, material, class etc., shall be linked with GIS, as directed by Departments representative. Detailing of all consumers with required information shall also be mapped.

7. CCTV SURVEYs, DE-SILTING AND CLEANING OF THE SEWERS

As a minimum, the following activities are required to be carried out:

i. Preliminary investigation and surveys.
ii. Site study & detection of buried manhole.
iii. Mobilization of de-silting equipments, pipe isolation arrangement, flow bypassing pumps, necessary safety equipments, etc as relevant standards and conditions of IS/BS/ASTM/Manuals and direction of EIC.
iv. Sewer flow control & Flow bypassing
v. De-silting and cleaning of sewer lines including removal of roots by mechanical de-silting equipment using super suction and high pressure water jetting machine, pay load carrier units.
vi. De-silting operation for non-man entry sewer lines shall be done with the help of Jetting & Suction machines. Wherever mechanized de-silting is not feasible due to site accessibility issues, de-silting shall be done by other conventional methods.
vii. Disposal of silt / sludge to the dumping place within 10 kms from the work spot after dewatering and as directed by EIC.
viii. Installation of necessary road signs, precautionary signs, fencing, etc as safety measures.
ix. After de-silting, the sewer line shall be surveyed using remote controlled CCTV video color camera equipment to know the existing condition of sewer line including the deflection in the sewer line. The camera unit will have pan, tilt & zoom arrangement and laser profiler to enable close inspection of any points of interest. The survey shall be recorded on video cassette / CD in Mpeg format and submitted to the EIC along with the inspection report.
x. After de-silting the sewer shall be cleaned with high pressure water jetting system.
xi. Post cleaning CCTV survey and reviews if the sewer is ready for rehabilitation.
xii. Installation of standard RCC Precast manholes.
xiii. Post CCTV survey to ensure that the sewer line is rehabilitated in the desired manner and it is ready for commissioning.
xiv. Restore the flow to normal after the de-silting, cleaning, lining and CCTV survey has been completed.
xv. Required and trained manpower shall be engaged to work in the sewer rehabilitation works having requisite knowledge and expertise.
xvi. Provision of night illumination as per requirement.
xvii. Providing all necessary safety equipment
xviii. Traffic control arrangement including providing traffic signboard, barricades, display of signboard and providing lighting during night.
xix. Submission of CCTV videos and condition assessment report in soft and hard copy.
xx. Associated works will include but not limited to flow management and diversion of flow, de-silting and cleaning of sewer, designing of improvement works including design of rehabilitation method, local repairs, restoration of all type of utilities, installation of

Manholes, implementation of safety management plan, traffic management and carrying out pre & post video survey of the rehabilitated sewers. Work also includes reinstatement of the site of the access shaft if any to its original condition.

xxi. Submission of vetted (from IIT/NIT or any approved agency acceptable to the EIC) Hydraulic model and design of proposed rehabilitation methods with specification of materials to be used.

xxii. Submission of construction methodology and construction plan of rehabilitation work.

xxiii. Submission of correct and detailed as-built drawings and other data to facilitate future requirement.

1.4.1. SUMMARY OBLIGATIONS UNDER THE CONTRACT

The summaries of obligations under the contract are mentioned below in the tabular form:

S No	Description	Scope of work					
		Design	Rehab	New	Build	Operate	Maintain
1.	Sewer network comprising of laterals, main, trunk and other sewers comprising of preferred pipe materials as DWC, HDPE, RCC NP-4 and Liner.						
a.	Pipe bursting technology	Yes	Yes	No	Yes	Yes	Yes
b.	CIPP lining technology	Yes	Yes	No	Yes	Yes	Yes
c.	Trenchless technology	Yes	No	Yes	Yes	Yes	Yes
d.	Open cut excavation	Yes	No	Yes	Yes	Yes	Yes
2.	House service connections up to the property chamber – uPVC pipes and fittings, etc.	Yes	Yes	Yes	Yes	Yes	Yes
3.	Operation and maintenance of complete assets created.	Yes	No	Yes	Yes	Yes	Yes
4.	Customer service centre	Yes	No	Yes	Yes	Yes	Yes

1.4.2. CONTRACTORS INSPECTION OF SITES

The Contractor is deemed to have visited the sites and familiarized himself of the conditions and restrictions under which the work will be executed. The omission of any details shall not relieve the Contractor of his prima facie obligation and responsibility under the Contract to carry out and successfully complete the contract. The Employer will entertain no monetary or other claims, made by the Contractor on the ground of 'want of knowledge'.

1.4.3. WORK PLAN

The Contractor shall prepare the work plan for the execution of works, which includes procurement of pipes before starting of the works. The Contractor shall submit the planning (Survey, reviewing and redesigning, Construction, Quality control, and Commissioning) within 14 days after issue of letter of acceptance and take necessary approvals for the same. The planning's shall be done on MS project/ Primavera software and indicate, resources such as material, manpower, cash-flow etc. to complete the works as per agreed time. The planning shall include all allowances to guard against delays caused due to inclement weather or its effects (such as floods or draughts), fire or industrial disputes, unless such events could not reasonably have been foreseen by an experienced Contractor.

1.5 SCOPE OF WORK DURING OPERATION AND MAINTENANCE PHASE

The Contractor will be required to operate and maintain the created assets in such way to meet the performance requirements and as agreed upon during the SIP stage. From the design, built completion date (which shall also mean sectional completion date; the Contractor shall collect and dispose off the sewage as part of sewerage services through the laid and commissioned sewerage system.) Contractor shall be responsible for operation, maintenance and management of the entire sewerage system services in project area as detailed below:

SN.	Obligations	Period
1.	Customer services and maintaining the sewerage infrastructure.	From date of construction completion certificate / sectional commissioning
2.	Managing the sewerage network for collection of sewage including maintenance of entire system from property chambers up to disposal / outfall in ultimate manhole or trunk main chamber within the battery limits of the project area.	DO
3.	Managing house sewer connections for collection of sewage from house properties.	DO

4.	Contractor will provide continuous on-the-job trainings that will start from the day the contractor gets mobilized, and other capacity building programs by the contractor as important regular activities for staff of the UMC.	DO

The contractor shall operate and maintain the entire works and all other allied works under this contract, for 10 years after the commissioning of the system. The first year of the O&M period (10 years) include 1 year defect liability period (DLP).

The contractor, under the scope of this work carry out the following activities, but these shall not requirement of other activities, which otherwise are required as per terms and conditions or to fulfil contractual responsibilities or are essential as per good industrial practices. The contractor shall be responsible for:

a) Providing the minimum personnel to be engaged during the Contract Agreement period:

b) Providing all required consumables required for functioning of the system. All costs including costs of all material, equipment, etc required for operation and/or maintenance (preventive and / or breakdown) to be borne by the contractor.

c) Maintaining;

- Repair history of all control equipment Logbooks.
- Observations made during patrolling of the pipe lines.

In addition to maintenance of above log-books, the contractor is required to maintain complaint register which must be investigated and remedial measures must immediately be taken.

d) Providing adequate spares and maintaining adequate inventory of accessories or equipment itself for repair of system so that the pipe and pipe appurtenances without any additional cost. At the end of the contract the contractor shall hand over the spares, tools, tackles.

e) Emergency Maintenance/ Periodic routine maintenance: providing a fleet consisting of suitable hauling machine, sufficient inspection/ patrolling vehicles and material hauling vehicles and any other vehicles/ machinery/ equipment of adequate and timely repairs and/or for routine/ periodic maintenance/ patrolling of the system.

f) Updating and periodic submissions of the operation and maintenance manual as defined in specifications for O&M works. The contractor shall take up all periodic maintenance works provided in the approved O&M manual.

g) Submission of monthly report.

h) Co-ordination with other contractors and / or agencies responsible for the Execution, operation and maintenance for regional schemes and Electric Supply Company. Pipeline Works Contractor is to provide all labour and material for O&M of all pipe lines which are supplied and laid under this contract as well as for existing pipe lines for accomplishing aims of this Project.

i) Repair of leaks/ sewer spills, damaged portion of road, embankment, pipe and pipe appurtenances, CD works and en-route structures identified during patrolling.

j) Emergency Repair(s) or burst(s) for maintaining regular supplies.

k) Operation of all valves quarterly and checks its proper functioning.

1.6 PHASING OF THE CONTRACT

The Contract is divided into two stages: (i) design and build, and (ii) Operation and maintenance services, spread over the contract period; from the stipulated date of Contract Commencement up to the Contract Completion Date.

(i) Mobilization, preparatory and construction period as per approved designs and

(ii) Operation, Maintenance, Manage, Repairs and Service Delivery Period during the contract period as per the sectional completion of work from commencement date (in case of sectional completion), till contract completion date.

1. *Detailed Engineering Design*

A. Mobilization Period

During the 30 days mobilization period the contractor is required to:

- Establish a furnished project office in Udaipur.
- Employ/ mobilize the staff required for starting the preparatory work
- Mobilize the survey teams
- Provide GIS based maps, hydraulic modelling and optimizing, project management etc.
- Mobilize vehicles, equipment, and communication equipment.

B. Preparatory Period (Preparation of design during preparatory period)

During the 30 days preparatory Period, the Contractor is required to:

- Familiarize himself with the project site condition after required consultation
- Collect data and maps etc. and review designs of sewer network, etc.
- Confirm/ conduct surveys to ascertain the levels, road width, existing services, obstacles, soil type, etc.
- Surveys for all underground utilities with geo-radar or other suitable technology and above ground utilities and marking on GIS based maps by linking with geo referenced points.
- Review the project report and the detailed project report in sewerage provided by Employer including all designs and provisions.
- Prepare and get approval of designs of entire sewer network, including civil and instrumentation etc complete.
- Prepare an asset inventory report.

The Detailed Project Report (DPR) including detailed engineering design and service improvement (SIP) which shall contain strategy for system improvement shall be submitted to the EIC within 150 days from the contract start date. Broadly the deliverables for Design period shall be as under:

(i) Design should be prepared including sectional completion requirements;
(ii) Detailed design & drawings;
(iii) Work plan, Methodology and timelines for implementation should be in line with the Employer's intentions;
(iv) Detailing of integrated Contract Management Information System by using latest software like Primavera, MS project , data capture, management and reporting structures, protocols including all related hardware, software, installation;
(v) Contractor Personnel Deployment Plan;
(vi) Construction Plant and equipment deployment plan;
(vii) Cash-flow for the entire contract with sectional completion break up;
(viii) Asset Replacement Schedule with justification;
(ix) Detailed methodology for continuous monitoring of the performance of the Contractor in achieving and maintaining the Performance Standards for release of the eligible Operating Payments;
(x) Compliance matrix of contract and service requirement, O&M requirement and other requirement like social, environmental, resettlement etc.

2. Construction, Testing & Commissioning

This shall be **18 months** from the date of approval of SIP. During this period the contractor shall be allowed for refinement of overall design of the system for long term efficiency, effectiveness and sustainability. All construction activities, testing and commissioning of the executed works shall be carried out during this phase.

3. Operation and maintenance

This shall be **10 years** from the date of commissioning / sectional commissioning of the project components. First one year shall be the defect liability period. Broadly the deliverables shall include:

(i) Annual Operating Plan (AOP) covering all operations, maintenance and management requirements in the Project Area;
(ii) Emergency Response Plan (ERP);
(iii) Public Relations Plan;
(iv) Standard Operating Procedures (SOPs) for routine operations and emergency responses;
(v) Detailing of an Integrated Management Information System (MIS) including its architecture, data capture, management and reporting structures, protocols including all related hardware, software, installation, and operation and maintenance requirements;
(vi) Periodic reporting plan including the formats for different performance reports;
(vii) The computer hardware and software improvement plan for continued operation of the MIS, instrumentation and SCADA.

1.7 SIP IMPLEMENTATION

The Scope of Services during the implementation Period shall essentially comprise of implementing the approved SIP based on the hydraulic model prepared for sewage network. SIP will be implemented in accordance to international best practice and industry standards and sufficient care shall be taken by the Contractor in minimizing supply interruptions, traffic disruptions and ensuring good and timely communications with the Customers in the Service Area. During work execution, contractor would be required to inform the residents, say, of a particular street, well in advance about the type of work, inconvenience expected, timelines for various works, etc. Contractor has to have a strong Public Relations and Community Outreach team. Contractor will plan sequencing of activities of sewer works in such a way that it could be made functional starting from the d/s ends without leaving missing gaps. All the Works and interventions proposed as part of the SIP shall be in conformity with the Specifications set out in the Employer's Requirements. Implementation of sewer collection networks shall be taken up simultaneously so that the people living in the area are not affected multiple times.

1.7.1. MANAGEMENT INFORMATION SYSTEM

Contractor shall develop, establish, operate and manage during the entire contract period a comprehensive Integrated Management Information System (MIS) in respect of all matters including but not limited to:

i. Design Built activities
ii. All the Operation and maintenance activities
iii. billings and collection systems;
iv. Customer services, including data bases relating to complaints and questions, response times and resolution;
v. Financial management, including accounting systems;
vi. Performance information systems; and
vii. Others as identified during SIP preparation and implementation.

1.7.2. BILLING AND REVENUE COLLECTION

The billing and revenue collection of sewerage charges are to be done with water bill or some other ways to be decided by Employer and therefore, billing and revenue collection shall be done by Employer / Line department.

1.7.3. PERIODIC REPORTS

The Contractor shall prepare and submit periodic reports on different plans, progress of Works, performance standards etc., including exceptional reports on emergencies if any. The reporting requirements are provided in Table below. The Contractor shall as part of the SIP develop the required formats for the periodic reports and also identify any critical reporting requirements in order to enable timely decision making by the Department.

Deliverable	First Report	Follow-up Tasks
Design Documents	Submit designs not later than 100 days from the Contract Commencement Date	Not applicable
Operating Performance Report (OPR); the OPR shall include: a detailed progress report on the implementation of the designs; and Performance Standards achieved or maintained during the month; staff details engaged at various centres; exceptional reports on emergencies, Environmental and Social Responsiveness etc.	Submit OPR for any and every month before the 10th day of subsequent month commencing from the commencement date	To be submitted every month.
Quarterly Performance Report (QPR); the QPR shall include a brief summary of the relevant issues detailed in the Monthly Performance Reports.	Submit Quarterly Performance Report for any and every quarter before day of subsequent quarter commencing from the Commencement Date	Repeat for every quarter
Management Information Systems (MIS)	Submit report not later than 100 days after Commencement Date	Generate monthly reports from MIS
Annual Operating Plan (AOP)	Submit Annual Operating Plan (AOP) not later than 100 days from the Commencement Date	Submit AOP for subsequent years not later than 90 days prior to end of previous year plan
Standard Operating Procedures (SOPs) for operation and management	Submit report not later than 360 days after Commencement Date	Complete implementation and training 30 days before commissioning of first section and subsequently whenever new employees join for O & M.
Annual Performance Report (APR); the APR shall include the annual accounts, cash flow, and financial performance including summary analysis of lapses in revenue collection.	Submit Annual Performance Report for any and every year before day of subsequent year	Repeat for every year
Asset and Facilities Register	Submit Asset and Facilities Register within 150 days from the Commencement Date	Submit updated Asset and Facilities Register before a day from the completion of an operating year

1.7.4. TESTING FACILITIES, LABORATORY

Within 28 days of issue of Notice to Proceed, the Contractor shall establish, in the campus of site office, an on-site fully furnished and adequately equipped field laboratory staffed by qualified personnel suitable for construction material testing except cement and steel etc. He will make the facility to test other material in the approved independent material testing laboratory. The name and qualifications of independent testing laboratories shall be submitted to EIC for approval no less than thirty calendar days prior to the date the laboratories are to be used. Once approved, dismissal and replacement of the approved independent testing laboratory shall require written authorization by the EIC. The site laboratory shall be functional till the design build work is completed. Laboratory and equipment shall become the property of the Contractor upon completion of the Contract If EIC found that Laboratory arranged by the Contractor is not being maintained properly then EIC has right to deduct a reasonable amount from payment. The calibration of the laboratory

equipment and instruments shall at the initial stage to be certified by agencies approved by the EIC. Laboratory equipment shall be properly maintained and calibrated throughout the period of the Contract by the Contractor at his own expense. The Contractor shall notify the EIC in sufficient advance prior to conducting any tests for the materials and work. The EIC will also inspect the laboratory and the contractor shall provide adequate facilities to the EIC for his independent verification of the accuracy and adequacy of the facilities.

The Contractor shall be responsible for the sampling, curing, and transport to the laboratories of all materials for testing, and all testing costs including laboratory fees, and/or all costs in running the on-site laboratory, i.e., chemicals, reagents, and other test consumables, staff, and utilities.

1.7.5. PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES

The Contractor will be held responsible for any damage to known services (i.e. overhead services that are visible within the Site and underground services surveyed by him and indicated on the drawings during SIP) and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval of the EIC. In the event of a service being damaged he shall inform the EIC and the authority concerned, the Contractor shall not repair any such service unless instructed to do so.

Contractor will map the underground utilities. Where no underground services are shown on the drawings or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall, in collaboration with the EIC, ascertain whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the EIC to make whatever arrangements are necessary for the protection, removal or diversion of the services before any construction activities commences.

As soon as any underground service not shown on the drawings is discovered, it shall be deemed to be a known service and the Contractor will be held responsible for any subsequent damage to it. If such a service is damaged during the course of its discovery, the cost of making good such damage will be met by the Contractor due to contractor not exercising reasonable diligence and that the damage was avoidable.

Where the authority concerned elects to carry out on its own account any alterations or protective measures, the Contractor shall co-operate with and allow such authority reasonable access and sufficient space and time to carry out the required work.

1.7.6. SIGNBOARDS

Signboards shall be placed at the project offices, at important locations and at each works site, in English, information about the project and Department, and the names of the Department's Representative and Contractor in a form and size to be agreed by the EIC. They shall be of durable construction capable of withstanding the effects of the climate until the end of the design build Period.

The Contractor shall keep the signboards in good repair for the duration of the contract and shall remove them on completion of the Contract.

Besides these signboards the Contractor shall not, except with the written authority of the EIC, exhibit or permit to be exhibited on the Site any other form of advertisement.

1.7.7. SITE DRAINAGE

The Contractor shall keep each Section of the Works well drained until the EIC certifies that it is substantially complete and shall ensure that, so far as is practicable, all work is carried out in the dry. Site areas shall be kept well drained and free from standing water except where this is impracticable having regard to methods of Temporary Works properly adopted by the Contractor.

The Contractor shall provide, operate and maintain in sufficient quantity such pumping equipment, well points, pipes and other equipment as may be necessary to minimize damage, inconvenience and interference and shall construct, operate and maintain all temporary cofferdams, sumps, ditches, drains and other temporary works as may be necessary to remove water from the Site while construction is in progress.

Such Temporary Works and construction equipment shall not be removed without the approval of the Department's Representative.

Notwithstanding any approval by the EIC of the Contractor's arrangements for the removal of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Works safe at all times and for making good at his own expense any damage to the Works.

The Contractor shall be responsible to keep the Site clear of water at whatever pump rate is found necessary. The Contractor's site drainage facilities shall not cause pollution in any local water courses; he shall be responsible for any legal action resulting from pollution events.

1.7.8. PROVISION OF TEMPORARY SERVICES

When the execution of the Works requires the temporary disconnection of existing public utilities, the Contractor shall provide the affected users with temporary services in at least the same standard as the original services. The alternative arrangement shall be made by laying temporary line/ by tanker/ mobile toilets before disconnection of existing public utilities, so as to cost minimum inconvenience to the public.

When forced to disconnect existing sewers/ drainage facility, the Contractor shall install temporary pipes of adequate size to carry off sewage/ drainage. No sewage/ drainage shall be allowed to flow upon the ground surface/ nallah or into the trench excavation.

No valve or other controls in public service facilities shall be operated by the Contractor without approval of the EIC and the relevant authorities. All users affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when service will be restored.

1.7.9. PROTECTION OF ADJOINING PROPERTY AND REINSTATEMENT UPON COMPLETION

The Contractor shall be responsible and take all measures in order to protect adjoining property including buildings, electrical and telephone poles, bridges and culverts, retaining walls, compound walls and fences, and other structures. Prior to the commencement of the activities, the Contractor shall assess the probability and extent of unavoidable damages, if any, to the building and properties and submit his assessment to the EIC. The EIC may make his own opinion and if required may order arrangements for protection or repair of such likely unavoidable damage in which event the Contractor shall complete the activities.

Temporary facilities shall be provided by the Contractor, only for as long as required after which he shall dismantle and remove the same from their place of use as speedily as possible. Reusable components shall be safely stored by the Contractor in his yard. The place of use shall be cleared and reinstated immediately to at least the condition existing before the temporary facilities were provided, and to the satisfaction of the EIC.

1.7.10. QUALITY CONTROL PLAN

The Contractor shall be responsible for establishing and maintaining procedures for quality control that will ensure that all aspects of the Works comply with the requirements of the Contract.

As soon as reasonably practicable prior to the commencement of Works the Contractor shall submit for approval a Quality Control Plan giving detailed proposals for control of quality of all aspects of work on the Site and at suppliers' workshops.

The Quality Control Plan shall include the following:

(i) a list of the Contractor's staff engaged in quality control
(ii) a list of any outside testing agencies employed by the Contractor for work in connection with quality control
(iii) where a testing laboratory is to be established on Site under the Contract, a list of major items of equipment and a layout of the laboratory, together details of the tests which will be carried out there

(iv) a list of manufactured items and materials, obtained by the Contractor for the Works, which require inspection at the suppliers' premises, and the proposed procedures for ensuring quality control

(v) a list of materials and operations to be inspected by the Contractor at the various stages of construction work on Site, together with inspection procedures, test types and frequencies

(vi) sample of proposed quality control records, testing and reporting forms.

Unless the Engineer permits otherwise, the approved Quality Control Plan shall be followed throughout the construction of the Works. Any approval by the Engineer of the Contractor's plan and procedures shall not relieve the Contractor of his obligation to ensure that the Works comply with the requirements of the Contract.

The Contractor shall appoint a suitably qualified member of his staff to be responsible for all aspects of quality control and to maintain effective liaison with the Engineer.

1.7.11. SAMPLING AND TESTING

The Contractor shall provide for the approval of the EIC, samples of all construction materials and manufactured items required for the Permanent Works. All samples rejected by the EIC shall be removed from Site. All approved samples shall be stored by the Contractor in a sample room, at a location approved by the EIC, for the duration of the Contract, and any materials or manufactured items subsequently delivered to Site for incorporation in the Permanent Works shall be of a quality at least equal to the approved sample. The approved samples may only be disposed of with the EICs approval.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the EIC. Samples for testing will generally be selected by the EIC from materials to be utilized in the project and all tests will be under the supervision of, and as directed by, and at such points as may be convenient to the EIC.

Material requiring testing shall be furnished in sufficient time before intended use so as to allow for testing. No materials represented by tests may be used prior to receipt of written approval of said materials.

The Contractor shall give the EIC 15 days notice in writing of the date on which any of the materials will be ready for testing or inspection at the suppliers' premises or at a laboratory approved by the EIC and unless the EIC shall attend at the appointed place and time the test may proceed in his absence. The Contractor shall in any case submit to the EIC within 3 days after every test such number of certified copies of the test readings as the EIC may require.

Approval by the EIC as to the placing of orders for materials or as to samples or tests shall not prejudice any of the EIC's powers under the Contract.

The provisions of this clause shall also apply to materials supplied under any nominated subcontract.

After all construction at each Section is completed and before applying for taking-over, the Contractor shall perform field tests as called for in the Specifications. The Contractor shall demonstrate to the EIC the proper operation of the facilities and the satisfactory performance of the individual components including all units and equipments, etc.

Any improper operation of the system or any improper or faulty construction shall be repaired or corrected to the satisfaction of the EIC. The Contractor shall make such changes, adjustments or replacement of equipment as may be required to make the same comply with the Specifications, or replace any defective parts or materials. In case any of the section of works or equipment as noted by the EIC, does not function and fulfil the requirement for which it is intended to ev, n after the same is repaired or corrected, that section of any work or equipment shall be constructed/replaced. Costs towards such construction/replacement will be borne by the contractor and no payment will be made to the contractor on this behalf. Some of the faulty equipment may require total replacement without going in to repair, the decision regarding the replacement of faulty unrepairable equipment will be made by EIC.

In addition to any special provision made herein as to sampling and testing materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the Works may be called for at any time by the EIC and these shall be furnished without delay by the Contractor at his own cost. Approved samples will be retained. The EIC will be at liberty to reject all materials and workmanship that are not equal or better in quality and character than such approved samples.

The tests required for quality control shall include but not be limited to:

a. tests conducted at the premises of the Contractor, Subcontractor, manufacturer or supplier which are normally or customarily carried out at such premises for the items or materials being supplied or the Works
b. tests which are normally or customarily conducted on the items or materials being supplied for the Works by the Contractor, Subcontractor, supplier or manufacturer but which have to be conducted at an approved laboratory because the necessary testing facilities are not available on the premises of the Contractor, Sub-Contractor, supplier and manufacturer
c. tests on locally obtained materials or items either on the Site or at an approved laboratory for the purpose of obtaining the approval of the EIC to the classification, use and compliance with the Specifications of such items or materials

d. routine quality control tests conducted by the Contractor to ensure compliance with the Specifications
e. regular testing of concrete and other materials as specified in the relevant section of the Technical Specifications
f. standard shop and Site acceptance tests.

1.7.12. SECTIONAL TESTS

Each section of sewer shall be tested for water tightness preferably between manholes. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90 cm length of the pipe open at the joints. Necessary codes and manuals shall be referred for carrying out such tests.

In case of concrete pipes with cement mortar joints, pipes shall be tested three days after the cement mortar joints have been made. It is necessary that the pipelines are filled with water for about 2 days before commencing the application of pressure to allow for the absorption by pipe wall.

The sewers are tested by plugging the upper end with a provision for an air outlet pipe with stopcock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through the air outlet, the stop cock is closed and water level in the funnel is raised to 2.5 m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and the quantity of water required to restore the original water level in the funnel is determined. The pipe line under pressure is then inspected while the funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on the pipe surface is permitted). Any sewer or part there of that does not meet the test shall be emptied and repaired or relaid as required and tested again.

The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 litres/mm dia. of pipes per km length per day.

Exoneration test for detection of leakage shall be carried out at a time when the ground water table is low.

Hydraulic testing of DI pipes shall be carried out as per Standard Specifications.

1.8 MANAGEMENT INFORMATION SYSTEM (MIS)

The Contractor shall establish, develop and maintain a Management Information System (MIS). The MIS shall have capabilities for facility management, inventory management, billing and collection management, operational job management and records and data management as well as all capabilities necessary for safe and efficient management, operation and maintenance of the Facilities.

The key objectives are:

A. Capability: The proposed MIS shall be capable of handling at least 20,000 customer records with ability to expand to 30,000 to record, monitor and report on all core business activities of the Contractor in connection with the services and obligations under this Contract.

B. Modules: The MIS shall have integrated modules for (1) record and monitoring the customer complaints, redressal (2) billing and collection system, (3) keep an accurate asset registry of the existing sewerage infrastructure, (4) manage all accounts related to the sewerage services and (5) record all operational data for monitoring efficacy and efficiency of the services.

1.9 AS-BUILT DRAWINGS AND GIS DATA CREATION

On the basis of the Working Drawings as approved by the EIC and after accounting any changes due to site conditions during the execution of work “As built drawing” shall be prepared by the contractor. Such drawings shall show the actual arrangements and exact locations of all sewer lines, structures and items of equipment installed under the Contract. The Contractor shall submit 5(five) no. of such As-Built Drawings clearly named as such to the EIC for approval before applying for the Taking-Over Certificate for the respective Section of the Works. After approval of the As Built Drawing the Contractor shall supply an electronic copy of the drawing in together with a licensed copy of the drafting software.

During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the approval to facilitate easy and accurate preparation of the As-Built Drawing.

Irrespective of the other contractual prerequisites no Section of the Works will be considered substantially completed until the respective As-Built Drawings have been approved by the EIC.

In parallel with the preparation of as-built drawings, the Contractor shall produce GIS data of the constructed works. The contractor conducts all necessary survey work, and shall ensure that vertical and horizontal measurements shall be captured at an accuracy of +/- 0.5m at a 95% confidence level, using the most suitable and cost-effective field data collection technology and methodology. All horizontal and vertical survey measurements will be referenced to the present Survey of India GIS geo reference.

The Contractor shall develop a checklist of QC checks for each type of deliverable and will be responsible for ensuring that these QC checks are performed. The Contractor shall assign a GIS quality officer to manage the quality review process. This officer shall be independent of the capture and production teams.

The Contractor shall be required to integrate the GIS deliverables with the existing pipe network data, i.e., ensure that the GIS data connects with any existing GIS system (to be updated by contractor at his own cost). This may entail revising GIS data of existing pipes at connection points. GIS data for the project will be delivered in an ArcGIS compliant file geo-database.

1.10 CONSTRUCTION PROGRAM AND PROGRESS OF WORKS

On Contractor shall prepare Construction Program as part of SIP. Construction Program shall be in the form of a Critical Path Method (CPM) Diagram showing, sequences, dependencies, durations and dates for execution of all major activities and items including sectional completion following the sub-divisions in the Bills of Quantities for the execution of the Works within the periods stated in the Contract. It shall be supported by:

a. Data of the construction methods
b. Equipment Utilization Schedule
c. Manpower Utilization Schedule
d. Subcontracting Schedule
e. Mobilization/Demobilization Schedule

The CPM diagram incorporating the above mentioned schedules shall be prepared using Microsoft Project, or similar approved project management software, and shall be presented in hard copy and electronic form to the EIC as part of SIP.

In carrying out the Works due attention shall be paid to all measures which can reasonably be taken in order to diminish the inconvenience which the work may cause to services and access to property.

1.11 AUTOMATION AND CONTROL

1.11.1. GENERAL

The proposed automation and control for the ABD area sewerage system include the following components:

a) Automation & Control system for 8 Nos. of existing LS and MWPS.
b) Monitoring of wet well of these LS and MWPS with level and flow sensors from a centralized location.

The principal items of work include:

a) Complete Instrumentation, Automation and SCADA Control facilities for the LS and MWPS works.
b) All software, including SCADA Software, Application Software, PLC Software and Programming Tools, etc.
c) All associated cable data highway.
d) Interface Communication network.
e) Integration, Testing and Commissioning of the complete system.

The integrated Instrumentation and Control System shall ensure the supervision and coordination of all controls and monitoring functions of the facilities of the project and allow their coordinated operation controlled from the centralized location.

The mains functions, features, general and particular technical requirements of the Automation & Control System have been described. The Contractor shall implement these functions and features, both tailored to the process and equipment to be controlled and monitored.

1.11.2. SCOPE OF WORK

a) The scope of supply includes all hardware and software required to ensure satisfactory operation of the SCADA system and facilities. The scope of work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's factories before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and erection and commissioning at site of various equipments and materials including associated hardware and software as specified in this document.
b) It is not the intent to specify completely herein, all details of design, construction and installation of the equipments and accessories. This implies that the Contractor shall supply all equipment, devices, apparatus, appliances, material and labour not herein specifically mentioned or included, but which may be found necessary to comply with the requirements implied in this specification. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be performed by the Contractor.
c) The Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability.
d) The system shall be consistent with modern practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.
e) The equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the Employer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance therewith.
f) Whether specifically called for or not, all accessories and work required for the completion of the work are deemed to be as a part of the bidder's scope, unless and until mentioned very clearly in exclusions.

The scope of work shall be a comprehensive functional system complete in all respects, including but not necessarily limited to the following:

a) Redundant Programmable Logic Controllers at each LS & MWPS with control panels, software and programming tools, Input/output modules, Interface cabinets, power supply units, communication interfaces, cables, etc. Each station shall also be provided two (2) Nos latest version of PC based Operator Work Stations each with 20" color TFT's, key boards, mouse for control, monitoring and programming function, one no. number heavy duty A3 size color inkjet printer, etc. These work stations shall perform control, monitoring and operation of all auxiliaries/drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC.

b) All instrumentation complete with instrumentation panels, all instruments comprising flow meters, level sensors, transmitters, pressure sensors, transducers, transmitters, float level switches, instrumentation control cables, etc. for meeting the functional requirements of the instrumentation system for the sewerage system facilities. The scope also includes :

- Connection of all instruments and equipment monitoring and control signals at all project sites to the PLC, as required.
- All instruments and associated power, control and signal cabling and wiring, as required.
- Calibration of all instruments at each plant site and provide calibration forms as required by this tender document.
- Establish and configure communications amongst field stations and SCADA Control Centre as per the requirement of this document.

c) Software - Supply of all necessary software, their license for use, and source codes for the process software that are specific for this project.

d) **Interface Cabling** - All interface cabling between Contractor-supplied equipment & Employer's panels within control room are included in the scope of the Contractor. The Contractor shall also install power cables from AC and DC Distribution Boards to the PLC's at sites, as required.

e) **Underground drainage and manhole monitoring system for Eight (8) LS & MWPS.**

Any other items not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

1.11.3. INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted by the contractor that the Sewerage System Pump Houses Programmable Logic Controllers and Manhole Monitoring System covered in this document shall be ultimately connected through dedicated communication links (Fibre Optics Cables/ Radio Communication/GSM Communication Network) to the SCADA Master Control Station to be installed by others at the Command & Control Centre of the Smart City Project. The scope of the contractor under this contract also covers integration of the complete Sewerage Instrumentation, Automation and Control system with the SCADA Master Control Station (s). The contractor shall have to co-ordinate with the other contractors in order to provide a fully functional SCADA system.

The details of SCADA system is provided in section VI B, separately, in this document.

2. PART-II TECHNICAL SPECIFICATIONS

2.1 GENERAL

The "Standard Specifications" issued by the Project Management Unit, RUIDP, shall be followed. Specifications for additional specialized items shall be adopted as stipulated in this section. For items that are not covered in either of the above cases, the relevant standards issued by BIS, PWD Rajasthan, CPWD, International standards and good engineering practices shall be referred to.

The Technical Standards consist of Technical Specification to be followed during Construction of Sewerage Network and other ancillary/ allied works for all Civil, Mechanical, Electrical, and Instrumentation required to be executed under this Contract. Notwithstanding the said Specifications, the Contractor shall adopt and follow necessary standards and approved Codes /specification wherever required for fulfilment of all the works under this contract. In respect of the Design-Build Services, the Contractor shall ensure that the design of the Sewerage Network is prepared by qualified designers who are professionally recognized to design the Sewerage Network and allied services. The Contractor warrants that the Contractor and its designers have the experience and capability necessary for the design. Planning of the entire system should be done in such a manner so as to optimize capital and operational costs on whole on sustainable basis.

This part of section outlines the detailed specifications of various components under scope of work for Design, Construction, Supply, Installation, testing and Commissioning of Sewerage Network including trenchless work, LS & MWPS, Operation and Maintenance of the entire sewerage system for 10 years which includes one year of defect liability period which starts from the date of commissioning comprising of Civil, Pipeline, Mechanical, Electrical and related Instrumentation SCADA works. Generally the following activities shall be carried out for each component of this contract, but shall not be limited to:

A) Investigations, Surveys and Submissions

i. Setting up fully equipped / staffed field office to carry out the required surveys and investigations and preparing the necessary designs and drawings at the very start of the System Improvement Plan (SIP).
ii. Cary out necessary verification of the topographical survey and soil investigations for the sewerage network.
iii. Preparation of System designs for local SCADA systems for monitoring and control, communications, etc for approval of the EIC.
iv. Planning, design and preparation of the working drawings for the proposed Works. Preparation and submission of the L-sections, layout plans and cross sections and conceptual drawings etc. and all other drawings at appropriate scale and details for planning and construction of all components of the project.
v. Submission of documents (designs, drawings, data sheets, etc.) and samples required according to the Contract for approval by the Employer's Representative of all design and drawings, material to be used, equipment specifications, etc., prior to construction.
vi. Submission of the design, drawings, catalogues and the technical data sheets of all the equipment.
vii. Preparation and submission of all detailed working drawings on the basis of conceptual designs and plans approved by the EIC.
viii. Equipment for surveying and measurement of the work shall be procured by the contractor for his use. The same shall also be made available to the EIC at the site for any work related with the contract with any additional charge.

B) Works

i. Setting up of suitably equipped/manned field offices for supervision of the works for the Contractor's staff and the Employer's Representative.
ii. Development of suitable storage spaces for construction material and equipment to be received for the works.
iii. Identification of suitable quarries/sources for construction material and get them approved from the Employer's Representative.

iv. Setting up laboratory and deploying qualified engineers/ technicians.
v. Setting up suitable labour camps with all water and sanitation arrangements and other facilities required under the relevant labour laws.
vi. Implementation of all the environmental and relevant social mitigation measures as required.
vii. Making arrangements for equipment and material required for maintaining safety of the sites and the workmen on site (helmets, boots, jackets, safety belts, gloves, scaffolding, barricading, etc.)
viii. Submission of initial work program and updating the same every month for approval by the Employer's Representative.
ix. Site clearance and levelling of site. Layout of the works as per the approved drawings.
x. Disposal of surplus soil as directed by Employer's Representative, construction of civil components of all the units, and maintaining the construction site in orderly manner.
xi. Carrying out tests on materials received and finished works and maintaining complete records and registers required on site as per the QA/QC Manual of RUIDP
xii. Manufacturing, shop testing, pre-dispatch inspection, packaging, transportation to site, providing transit insurance, storage, handling at site, installation, sectional testing, pre-commissioning testing, trial runs and commissioning of all components of the system including the pipes, fittings, hydraulic, mechanical, electrical, electro-mechanical and instrumentation equipment.
xiii. Providing spares, tools and tackles.
xiv. Approval of all sources of materials and equipments shall be obtained in writing from the EIC before their use on the project.

2.2 SPECIFICATIONS

2.2.1 DOUBLE WALL CORRUGATED (DWC) PIPES

The manufacturing, testing, supplying and testing at work sites of HDPE-DWC pipes shall comply with IS 16098 Part-II: 2013 and all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern:

IS4905 : Methods for random sampling.

IS5382 : Specification for rubber sealing rings for gas mains, water mains and sewers (first revision). Type-I &Type-VI

IS12235: Methods of test for thermoplastics pipes &fittings. (Part 1):1986 Method of measurement of outside diameter. (Part5):1986 Reversion test (Part8):1986 Internal hydrostatic pressure test

IS 16098Part-II: Structured wall plastics pipes for non-pressure drainage and sewerage-specifications.

2.2.2 UNPLASTICIZED POLYVINYL CHLORIDE (U-PVC) PIPES AND FITTINGS

The materials used in the manufacture of uPVC pipes and fittings shall comply with the physical properties indicated in IS 4985-2000. They shall not contain any matter which could impart taste, odour, toxicity or be harmful to health or adversely affect the water conveyed. Unless specified otherwise joints shall be of the push-fit type complying with IS 4985 or BS 4346 having an elastomeric sealing ring. Joints shall be made in accordance with the manufacturer's instructions. Fittings shall be injection-moulded in PVC to the requirements of IS 4985 or BS 4346. Fabricated uPVC fittings or fittings manufactured in other materials will only be permitted when the material and method of manufacture are approved by the Employers Representative.

2.2.3 RCC NP-4 PIPES

Manufacturing, testing, providing, laying, jointing and testing at work sites shall comply with all currently applicable statutes, regulations, standards and codes.

a) IS:458:1988 –Specification for precast concrete pipes(with and without reinforcement)
b) IS:3597:1985- Method of tests for concrete pipes.
c) IS:432:1982 – Specification for mild steel and medium (tensile steel bars and hand drawn steel) wires for concrete reinforcement.
d) IS:5382:1985-Specification for rubber sealing rings for gas mains, water mains and sewers.
e) IS:516: -Method of test for strength of concrete.
f) IS:456:2000- Code of practice for plain and reinforced concrete
g) IS:783:1985- Code of practice for laying of concrete pipes.

2.2.4 HDPE PIPES

HDPE pipes shall be as per IS 14333 and suitable for butt fusion welding. For HDPE pipes the material grade and pressure rating shall be PE 80 and PN 4 respectively.

2.2.5 PRECAST RCC MANHOLES

It is proposed to provide circular manholes. The general construction of the manhole shall be RCC Precast manholes as per the approved drawings. The contractor will be responsible to ensure procurement and placement of the precast elements in position without any damage. The jointing of the various elements will be made so as to achieve the required water tightness. RCC pre-cast and RCC cast in situ elements shall be tested in accordance with the provisions of IS456:2000.

The manholes shall generally conform to I.S. 4111.RCC works shall generally confirm to IS.456-2000. The location of manhole shall be as per the approved drawing or layout given by the Project Manager or as directed by the Project Manager. The Manhole dimensions and other details shall be as per the approved drawings. The Contractor, while constructing the manholes, shall suitably provide PVC-U pipe connection lines for the house sewer connection to prevent the undue breaking of man hole or road in future, as directed by the Project Manager. The location of manholes shall be as per the approved drawing or layout given by the Project Manager. The vent shaft connection shall be as per the approved drawing.

Pre-cast RCC M – 40 manhole & sewer chambers shall be procured / constructed simultaneously with the laying of sewers as per approved drawing and detailed specification.

RCC precast manholes shall be constructed as per approved drawings.

In case of Pre-cast RCC manholes, design mix concrete of grade M-40 shall only be used for the precast manhole elements as per approved drawings.

The Contractor shall provide steel reinforcement as per design requirement in each Pre- Cast M-40 Grade Circular Rings including Starter Base Wall at the bottom of the manhole chamber, subject to a minimum of nominal reinforcement as per Code of “Practice of Plain and Reinforced Concrete” IS:456 2000. No extra payment shall be made to the contractor on this part. The Contractor should therefore take provisions accordingly.

Contractor shall study the design, drawings and specifications carefully and if felt necessary, may increase the sectional thickness, reinforcement or the grade of concrete suitably. No extra payment shall be made to the contractor over the rates quoted by the contractor for any modifications / changes proposed by him. The contractor shall be fully responsible for the structural safety of the pre-cast manhole elements/components.

Any data or information received by the Contractor, from the Employer or otherwise, shall not relieve the Contractor from his responsibility for the design and execution and structural stability of the pre-cast elements.

The safety steps in the Manhole shall be of Plastic Encapsulated Steel reinforced. Minimum 3 mm thick Polypropylene copolymer is injection moulded around a 12 mm dia tor-steel bar shall be in Orange Color. Minimum overall length of 260 mm and width of 165mm Protruding legs have a 2 mm tread on top surface by dots for providing an antiskid surface Designed to withstand the bend test and chemical resistance test as per specification Polypropylene copolymer conforming to ASTM D-4101/IS-10910 construction12 mm dia

Fe-415 Steel reinforcement conforming to IS – 1786 the manhole step can be driven into two 25 mm diameter parallel pre-formed holes or drilled holes, 137 mm centre to centre, 135 mm deep or in case of installation in brick wall the footrest can be placed in the brick wall during its construction.

2.2.6 MANHOLE FRAME AND COVER

Steel Fibre Reinforced Concrete (SFRC) frame and cover shall be used for covering the manhole.

The selection of samples per lot for testing, failure percentage, no. of test, Concrete mix curing, etc shall be as per IS 12592 (part-I) for Pre-Cast Concrete Manhole Cover. The load of class AA shall be as per IRC guidelines.

The Manhole cover shall be heavy duty and shall confirm to IS 12592 (Part I & II). The inspection and testing for these shall be done by Third Party agency also in the presence of EIC or his representative. The load test shall be done in accordance with Table 1 of IS 12592 (Part – I).The cover & frame shall be manufactured as per approved drawing. The frame and cover of manhole shall be in SFRC as per approved drawing.

2.2.7 SEWER LAYING BY TRENCHLESS METHOD

The contractor shall be responsible for the design of the pipes used for the trenchless method including all joints, for the design of the thrust and reception pits including support and thrust wall and for design of the jacking system in general. The contractor after carrying out field investigations and based on the guidelines provided by “Indian Society of Trenchless Technology” shall come up with selection of best trenchless technology suitable for particular sections for laying the sewer. The following codes shall be referred to:

a) Code of practice for Horizontal Directional Drilling Suiting Indian Condition
b) Code of practice for Micro Tunnelling and Pipe Jacking Suiting Indian Condition
c) Code of practice for Glass Reinforced Pipe Technique Suiting Indian Condition
d) Code of practice for pipe Bursting Suiting Indian Condition
e) Code of practice for cured in place pipe Technique Suiting Indian Condition
f) Trenchless Technology Selection Guidelines
g) Standard Operating Procedure for Application of Trenchless Technology
h) Manual of site Investigation for Trenchless Projects
i) Trenchless technology Risk Mitigation Manual and Specifications

The contractor shall submit the method statement which shall include the following as minimum:

a) List of equipment and resources
b) Detailed step by step procedure describing how work will be carried out
c) Type of pipe suitable for the trenchless technology chosen by the contractor and supporting design calculations
d) Safety arrangements
e) Converting thrust and reception pits into manholes.

2.2.8 SEWER REHABILITATION BY PIPE BURSTING TECHNOLOGY

1. The replacement of sewers by 'No-Dig" method of pipe bursting with appropriate upsizing / replacement with same size or dia as per the design requirement of the existing sewer shall be carried out as per relevant IS / BIS / International standards / ASTM Standard / WRC's SRM and technical specification and as per direction of engineer in charge. The pipe bursting equipment shall be capable of replacing existing clay ware / stoneware / RCC/CI sewer pipe. New pipe material proposed shall be of polyethylene of PE 80 grade with suitable pipe thickness as per site design conditions and shall comply with relevant IS/BIS/international standards/ ASTM Standard/ WRC's SRM technical specification and as per engineer in charge. Pipe bursting shall be done from the existing manhole to the next manhole as per requirement. These manholes shall act as launching and receiving pits.
2. The jointing of pipes shall be done without any pipe insertion pits. As a guideline it is being mentioned here that Snap-Fit (Patterned rubber ring joint) arrangement can be used, it is

the responsibility of the contractor to arrive at a most feasible solution and technology for making such joints and avoid any pipe insertion pits.

3. HDPE pipes of PE 80 / PE 100 grade and the pipe wall thickness shall be as per PN4/ PN6 grade as per IS 14333. The contractor shall submit the design report on structural stability of the pipe used as replacement of the existing old pipes. The pipe thickness shall be designed so as to take care of the superimposed loads produced from the combination of earth pressure, hydrostatic loads and traffic surcharge loads for each particular pipe section. The vertical earth pressure will comprise full height of soil above the pipe without reduction in trench effects. It shall also be assumed that water table is located at surface level. Traffic surcharge load also consider for a maximum load conditions. The pipe thickness is selected based on the SDR rating and relevant IS/BIS/international standards/ ASTM Standard/ WRC's SRM technical specification and as per engineer in charge.
4. After Hydraulic modeling and design the sequence of operations shall be as follows but not limited to-
   i. Initial survey of area and the sewer line to be replaced.
   ii. Temporary plugging / isolation of the upstream and downstream MH of sewer to be replaced
   iii. Temporary diversion of flow and maintaining of flow either by diversion or pumping to the nearest sewer / any other approved outlets as per direction of engineer in charge.
   iv. Structural assessment and making recommendations on the appropriate size of new pipe to be laid before proceeding with replacement work.
   v. Plugging of the lateral or other such connections and its permanent reconnection by diversion to the nearest manhole.
   vi. After completion of the above, the following shall be carried out prior to bursting.
   vii. Carry out de-silting of the sewer which is to be replaced.
   viii. Submission of detailed design calculations.
   ix. Carry out quality control tests or other such tests to be witnessed by EIC.
   x. Actual replacement of pipeline by NO-DIG' pipe bursting Method.
   xi. Construct new Pre-Cast Manholes.
   xii. Final sewer cleaning and CCTV inspection.
   xiii. Remove plugs and establish flow and reinstate original flow conditions.
   xiv. Restore the all type of utilities.

2.2.9 SEWER REHABILITATION BY CURED-IN-PLACE-PIPE (CIPP) TECHNOLOGY

1. Surface preparation of the sewer to be rehabilitated is the most important work to be carried out prior to installation of the liner.
2. Initially, all manholes/access points along the length of the pipe to be lined have to be located and distances are measured.
3. Once this is achieved, the number and lengths of the liners to be installed shall be determined. Important characteristics are: the material of the pipe, the number of bends, the diameter of the pipe, and the condition of the pipe and possible diameter-reductions.
4. Pre liner shall be used if the host pipe does not dry up even after cleaning or due to heavy infiltration into the host pipe so as to prevent "wash out" of the resin during the installation of main Liner.
5. The thickness of the liners shall be determined according to the pipe conditions. The rehabilitated pipe should be able to resist all the super-imposed loads acting on the pipe (soil pressure, hydrostatic pressure, and live loads).
6. Design of the liner shall be as per ASTM F1216-07 "Standard Practice/WRC SRM for

Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube".

7. The installation of the liner shall be done as per ASTM F1216-07 and ASTM F 1743-96 "Standard practice for Rehabilitation of Existing pipelines and conduits by Pulled-in-place Installation of Cured-in-place Thermosetting Resin pipe (CIPP)".
8. The service life of the liner installed should have a life of more than 50 years under severe conditions and toxic effect of sewage and gases, resistant to scouring, acids, alkalis, solvent, etc and shall provide for 100% water tightness.
9. The Liner shall be designed as a complete structural stand alone liner and shall meet the following requirements.
    a. Liners shall be designed to have sufficient strength to support superimposed loadings such as earth pressure, hydrostatic loads and traffic surcharged load, etc.
    b. Liner shall be designed to seal the sewer to prevent the infiltration of ground water into the sewer and the leakage of sewage into the surrounding ground.
    c. Liner shall be designed to withstand all construction loads including handling, lifting, installation aid, without overstressing the liner or cracking.
    d. The lining of the sewer shall be totally wrinkle free and retain the grade and level of the existing sewer.
    e. The internal surface of the liner at the joints shall be flush with a tolerance step of not more than 1 mm between adjoining pipes.
    f. The joints shall be leak free, water tight and able to resist opening due to external or internal forces.
    g. Details shall be provided for cutting and making good of the laterals and branches. Necessary details shall be provided for end sealing of the liner.
    h. Design, manufacture and delivery of the liner will comply with ISO 9001 2000. Necessary certificate shall submit.
    i. All design calculations and area reduction calculation shall provide.

2.2.10 OPERATION AND MAINTENANCE OF THE SEWERAGE NETWORK SYSTEM

The Contractor shall ensure the Operation and Maintenance of the Sewerage Network; in compliance to the guidelines contained in the Manual on “Sewerage & Sewage Treatment”, latest edition as published by the Central Public Health Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India, New Delhi and the prescription laid down here under.

a) Standard Operating procedures (SOP)

Operating instructions and Standard Operating Procedures (SOP) shall be formulated by the Contractor for all sewerage network component, equipment, etc comprising of process equipment schedules, operation & maintenance data, etc. The operating parameters shall be optimized based on the data collected on commissioning of the facilities. All the activities in the preventive maintenance schedule shall be followed without any lapse. Indicative functions that are expected to be performed at each site are given below:

1. The Contractor shall make his own arrangements at his own cost for staff required for operation and maintenance of networks and other assets, sewer cleaning vehicles, CCTV machine and other equipment maintenance of all types such as routine, breakdown, periodic and repair maintenance, replacement of damaged/unserviceable sewers, maintenance of house service connections. The Contractor will also maintain a Customer grievance redressal centre and ensure that O&M services meet the standards of services/service levels.
2. The work of sewer maintenance would also include the following:
    i. Checking of manhole condition for deposition of silt, flow, new connections done, damaged walls or steps, manhole covers, clogged vertical pipes in drop manholes etc. While the

cleaning of the manhole, pipes etc., will be undertaken by the gang, repairs etc. may be reported to be handled by a separate construction gang of mason and helpers. It is preferable that the repair gang comes out on the work when the sewer cleaning or maintenance gang is working, so that brick bats, debris mortar etc., which fall in the manhole are removed there and then. This will cause a major blockage if the same is allowed to flow into the sewer line, which usually occurs when repairs are done separately. In such cases, a couple of sewer men should be deputed to clean the manhole of the debris immediately after repair work is completed.

ii. Checking of the sewer line between two successive manholes for silting and flow conditions and remove the deposited silt and
iii. Checking for any harmful and extraneous matter entering into the sewer lines so that further investigation for the cause and location can be determined.
iv. Check air release valves in rising or force mains, sluice gates or stoppage in the sewer lines, overflow arrangement etc.
v. Operation of jetting machine
vi. Carrying out CCTV inspection
vii. Identify and inform the Employer / Employer's Representative about the illegal connections on the Sewerage Network within seven days of its being detected.
viii. The Contractor shall submit a weekly report to the Employer detailing the Operation and Maintenance indicating the labour hours expended and other Consumables consumed and also problems faced and rectified.
ix. The Contractor shall submit detailed schedule/manual of all O& M activities with references of equipment manufacturers' maintenance schedules/manuals to the Employer for review and approval.
x. The Contractor shall submit Guidelines and Instructions manual for the maintenance staff of all levels for all the tools, plants and equipment and Operating Sewerage Network to maintain the service levels within the standards prescribed within the contract;
xi. The Contractor shall carry out all O&M activities as per the approved Operation and Maintenance Manuals.
xii. During the Operation and Maintenance period, the Contractor shall ensure that the sewage detention time in wet well not exceeds 30 min. and there is no backflow of sewage. The Contractor is responsible for maintaining back up power arrangements at his cost to ensure that the O&M services are not affected due to failure of power supply from the Public Utility Company.
xiii. The Contractor's responsibility shall also include the safety and security of the Works during the course of Operation and Maintenance.

b) Maintenance & repairs

A properly designed sewerage network shall be capable of delivering desired output at all times. During Operation and Maintenance period, the Contractor shall appoint an Operational manager for whole sewer system In addition, the Contractor shall appoint suitable number of cleaners, helpers, labourers as required for the operation and maintenance of complete proposed sewerage network for three shifts and adequate other staff/supporting personnel during general Shift. To ensure the desired output at all times, a proper maintenance management plan shall be formulated, which shall have following arrangements:

i. Minimum time for rectification
   - Blockage and overflows - 12hours
   - Stolen / Broken man hole covers - 12hours
   - Sewer spills from main sewer, branch and house service connections (between property chamber and public - 72hours

ii. Staff

The Contractor shall mention the personnel required for O&M in his bid. The work shall be carried out on a 24 hour basis without intermission and the staff deployed by the Contractor shall be in accordance with this contract. The work shall be carried out on a 24 hr. basis, without intermission and the staff deployed by the Contractor shall be in accordance with this contract. Minimum staff required for sewerage network shall be as given in pint 1.5 above:

The Contractor shall give or provide all necessary superintendence during the O&M and as long thereafter as the Employer may consider necessary.
No labour below the age to 18 years shall be employed on the work
Employer shall be authorized to direct the contracting agency to remove any or all staff employed on O&M of the sewerage network if in his opinion continued presence of such staff is detrimental to safety or proper O&M of the sewerage network. The Contractor shall comply with such directions & post suitable substitute(s) thereof. Whenever the EIC has to inform the Contractor in writing that any person on the work is in his opinion unsatisfactory or/incompetent or unfaithful or dishonest, untruthful or disorderly or to be otherwise unsuitable/such person shall be discharged by the Contractor from the work and shall not be employed again on it.

iii. Report and recordkeeping

The Contractor shall maintain a record for the entire Term of the following:

a) record of all consumables, tools, equipment's manhole covers, etc. used / replaced towards operations and maintenance of the Sewerage Network;
b) identification and reporting of illegal connections on the sewerage network;
c) Nature and scope of any ancillary activities being carried out in accordance with the terms and conditions of this Contract; and
d) Record all complaints received regarding sewer blockage and clearance with same date and time.
e) Record condition of sewer found at the time of attending complaint. Damage notice should be recorded by attending staff.

iv. Operation and maintenance manual

a) The Contractor shall prepare a detailed program (referred to as O&M Manual) covering the operation and maintenance of the Sewerage Network as a whole. This program shall include the work and activities as relevant to the specific items and technology.
b) The Contractor shall provide 4 copies of draft O&M Manual to the Employer, at the time of the commissioning of the project and on approval of draft, 10 copies of operation &maintenance manual shall be supplied by the Contractor.
c) The O&M Manual shall include the daily, weekly, monthly, quarterly, half yearly and annual checks and remedies if necessary to be performed for effective operation of the proposed sewerage system
d) Without limiting the generality of the foregoing the O&M Manual shall include descriptions, procedures; schedule of maintenance, and shall comply with the requirements, set forth in the provisions of the Bid Documents.
e) The draft of the O&M Manual shall be subject to the review and approval of Employer, which shall have the right to make any changes and revisions to the O&M Manual as it may deem appropriate. The Contractor shall revise such draft O&M Manual prior to the commencement of the O&M period.
f) Employer shall have the right to require revisions to the draft O&M Manual as it may deem appropriate. The Contractor shall prepare and submit to Employer, for its review and approval, 30 days prior to the proposed date of commencement of O&M, a revised draft O&M Manual which reflects all changes, revisions and modifications. The Contractor shall prepare the O&M Manual, as approved by the Employer, prior to the start of O&M.

v. Planned and scheduled maintenance (preventive)

a) The contractor shall prepare and follow a maintenance plan, detailing the maintenance activities scheduled for each of the component of the sewerage network at periodic intervals and approved by the Employer.
b) Every part of the works and all the materials to be used therein shall be subjected to such tests from time to time during the execution of the work as the Employer/Employer Representative may direct and the whole of such tests shall in all cases be made at the Contractor's sole expense.

c) The work shall be carried on and completed under the exclusive control direction and supervision and to the satisfaction of the Employer/Employer Representative. The Employer/Employers Representative shall likewise have full power to reject or condemn any work or material that he may deem unsuitable. In case of any work or material being rejected by the Employers Representative, the Contractor shall immediately remove and replace the same to the satisfaction of the Employer/Employer Representative or the Employer/Employer Representative shall have full powers to get the same removed and replaced and deduct the expenditure incurred in the process from any amount due or that may become due to the Contractor.
d) If any material brought to the site of works, be in the judgment of the Engineer, found inferior or improper & not as per described standards, the said materials or workmanship shall where required by the Employer/Employer Representative shall be removed or amended by the Contractor forthwith or within such period for every breach by the Contractor in this clause.
e) All leakages should be attended and all network blockages shall be removed within three days of them being identified and reported. The performance indicators shall be adhered to in any case. All the valves/gates which are not used regularly should be operated at least once a week and make sure that they are properly lubricated/greased.
f) Consumables such as Manhole covers, POL (petrol/Diesel Oil & Lubricants), etc has to be arranged by the Contractor as and when needed as per manufactures recommendations for periodical maintenance of entire Network.
g) The Contractor shall carry out mandatory biannual cleaning of network before and after the monsoon season including cleaning of all manhole chambers and collection network irrespective of the regular maintenance work.
h) In case of major repair due to normal wear and tear/break down, the Contractor should bring the same to the notice of the Employer/Employer Representative immediately and necessary measures for its repair should be taken simultaneously. Breakdown, all repairs of any kind are to be attended by the Contractor.

2.2.11 AUTOMATION AND CONTROL SYSTEM

The Details of SCADA system is given in Section-VI B, of this document separately.

NOTE: Wherever any Brand name is mentioned as a benchmark for Quality, it should be read as "BRAND NAME OR EQUIVALENT" for all the items mentioned in different Sections of this Document.

Section-5C (Electrical Works)

Scope of work

Introduction

Under smart city, the vision to integrate information and communication technology (ICT) and Internet of things technology in a secure fashion to manage a city's assets. These assets include local department's information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. A smart city is promoted to use urban informatics and technology to improve the efficiency of services. ICT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data are collected from citizens and devices then processed and analyzed. The information and knowledge gathering and tackling inefficiency, it is the objective of the Udaipur Smart City.

SUMMARY OF WORK:

The work to be carried out is a part of smart city mission, The package consists of replacement of Existing overhead HT **LT,** distribution system with underground HT**, LT** cabling and providing of RING MAIN UNITS(RMU) for ring circuits, The existing Pole mounted distribution substation has to be replaced with state of art compact packaged substations Dry **types** with respect to site requirements, LT feeder pillars and distribution feeder pillars to be installed at various places and end users (Consumer) to be connected from these distribution feeder pillars Smart Compact Secondary Sub Stations placed at selected key locations in a power distribution network can provide remote monitoring and control through simple, cost effective signal collection, processing and control of the distribution network. The intelligent Ring Main Units play a crucial role in distribution network and the automated measurement, monitoring, control and communication capabilities provide all the information needed to implement automated fault identification, fault isolation and power restoration. SCADA system provides remote monitoring and control of the substation and power distribution network from the control center, resulting in a more efficient management of the power system.

Scope of work - This Section contains the Scope of work, Specifications of work, supplementary information and Drawings of proposed works that describe the Works to be procured on design build and operate basis. The duration of the Design and Construction phase will be 24 months in total, followed by Operation and Maintenance Phase of 10 years. The scope of work is as follows:

Design Phase (06 Months)

1. Detailed survey
2. Route Plan for HT & LT Line
3. Location of Distribution sub-station, Distribution feeder pillar etc.
4. Preparing drawing section wise and get approval from engineer in charge.
5. Preparing Detailed Engineering Design, drawings, data, operational manual etc.

Construction Phase (18 Months)

6. Complete manufacture, including vendor testing & supply of all materials / equipment from the approved vendor or from his manufacturing units.

7. Receipt, storage, preservation and conservation of all equipment at the site.
8. Pre-assembly, if any, erection, testing and commissioning of all the equipment.
9. Performing reliability tests and performance guarantee tests on completion of installation and commissioning of equipment.
10. Loading, unloading and transportation of material as required.
11. Installation of 33 KV grades 3 Core 300 Sq mm screened Aluminium conductor, XLPE insulated PVC sheathed armoured cable in the permanent underground RCC DUCT/HDPE Pipe to be constructed on the road sides. Form Madhuban to Power house feeder. Installation of One no. Standby cable of above size in HT system. (Length approx 3.2 KM)
12. Installation of 11 KV grade cable of 3 Core 185 Sq mm Aluminum conductors, XLPE insulated PVC sheathed armoured in the permanent underground RCC DUCT to be constructed on the road sides. Installation of One no. Standby cable of above size in HT system. (Length approx 40 KM)
13. Installation of SCADA compatible, 11 KV, 630 Amp. SF6 insulated RMU having 3/4 Nos. Motorized load break Isolators and circuit breaker if required at T- off/Junction point (Qty Approx 60 Nos).
14. Installation of SCADA compatible compact substation (CSS) of 11KV/433V having RMU, Transformer, LT feeder Panel and SCADA equipment. (Qty Approx 140 Nos).
15. CSS will be equipped with state of art Feeder Remote Terminal Units for ultimation connection to SCADA, Master Control Station at SCADA Control Centre (described separately in this document).
16. CSS, RMU and distribution Feeder Pillar shall be heritage look by colour paint are strikers as per direction of engineer in charge.
17. Installation of 1.1 KV grade 4 Core 185 Sq mm Aluminium conductors XLPE insulated PVC sheathed armoured in the permanent underground RCC DUCT to be constructed on the road sides. Installation of One Nos Standby cable of above size in LT system. (Length approx 80 KM)
18. Installation of SCADA compatible 440 Volt, 400 Amp Distribution Feeder Pillar along the road on the footpath having ACB/MCCB as Incomer, Busbar, and MCB/Contactor for the outgoing. (Qty approx 1500 Nos).
19. Installation and termination of LT service cable 2/4 core 4/6/10/16 Sq mm to the individual meter. Laying of these service cables through the underground multi-utility duct or conduits as necessary to ensure last mile (end user) connectivity. Laying of service cable from the nearest point in the duct to the consumer premises shall be through underground heavy duty PVC pipes (Average Length of cable per connection shall be 25 M)
20. Supply of the LT power output from the CSS to feed various Distribution feeder pillars placed approx. 60 to 70 meters apart along the road on the footpath.

21. Looping of the Distribution feeder pillar with 4 Core 185 Sq. mm Aluminum Conductor, XLPE insulated PVC sheathed armoured underground cable.

22. Construction of the RCC foundation for the compact package substation (CSS), RMU, LT feeder pillars/distribution feeder pillars etc.

23. Earthing of CSS, Distribution feeder pillars, cable, cable tray by maintenance free chemical electrode earthing as per relevant IS code. 2 nos of chemical electrode earthing per CSS (Qty approx 2000 Nos). Earthing to be done as per relevant and latest IS CODES

24. Removal of the existing street lighting system and replacing with wall mounted street lighting system. The average LUX Level of 30 has to be maintained on the service road and the wall mounted light with carriage accessory cable of required LED Wattage has to be placed in such a way that the average 30 LUX on the road should be maintained uniformly.

25. Installation of 1.1KV grade cable of 3 Core 16 Sq mm, Aluminium conductor, XLPE insulated, PVC sheathed armoured for the Street light shall be laid through the wall with the help of the clamp, and somewhere in the permanent underground RCC DUCT to be constructed on the road sides.(Length approx 80 KM)

26. Dismantling and refilling the same of existing 33KV, 11KV and LT overhead lines, transformer, DP, pole service, cable, street lighting system on these roads and returning the same without any damage to USCL/AVVNL stores under a receipt from USCL/AVVNL (length approx 85 km)

Operation and Maintenance Phase (10 Years)

27. The selected bidder will have to operate and maintain the facilities created, for a period of 10 years,, from the date of issue of completion Certificate, including Defect Liability Period (DLP) of 12 months.

    NOTE:- The above works to be done as per specifications and relevant IS CODES.

Technical Specifications
PART-1: Compact type Package Sub-station

1.0 SCOPE:

This specification covers Design, Engineering, Manufacture, Assembly, Stage testing, Inspection, Testing before supply, packing and delivery at stores, stores of 11KV/433V SCADA compatible Package Substation Outdoor type. The Unit comprising of Ring Main Unit (RMU), Transformer, LT Feeder Panel and RTU and their components. The Unit should be upgradable for future requirement. The Unit to be supplied against this specification is required for vital installations where continuity of service is very important. The design, materials and manufacture of the package Substation shall be the highest order to ensure continuous and trouble free service over the years. The package Substation should be provided with necessary terminal blocks which shall be used for connecting the RTUs for automation.

Preferred Makes of CSS – Schneider / ABB / Siemens / Raychem / Voltamp / CG / C&S

2.0 APPLICABLE CODE & STANDARDS:

4.1 All equipment and material shall be designed, manufactured and tested in accordance with the latest applicable IEC and equivalent IS standards.
4.2 The 11KV/433V Package Substation Design must be as per IEC 61330/62271-202 and equivalent IS codes.
4.3 The Package Substation offered shall in general comply with the latest issues including amendments of the following standards.

Particulars	**Standards**
High Voltage Low Voltage Pre-Fabricated Substation	IEC 61330/ 62271-202
High Voltage Switchgear and control gear	IEC 60265/ IEC 60694
Metal Enclosed High Voltage Switchgear	IEC 60298/ IEC62271-200
Low Voltage Switchgear and control gear	IEC 60439
Power Transformers	IEC 60076

3.0 Applicable 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 : up to 95%
Altitude of Installation up to 1000m

The Enclosure of High Voltage switchgear, Low Voltage switchgear & 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.

4.0 General Design Criteria

4.1 The required Package Substation shall consist 11KV Extensible SF6 Gas insulated Ring Main Unit (RMU) with two Nos. Load Break Switch and one Nos. SF6/Vacuum Circuit Breaker as transformer protection, Dry Type Transformer, Low Voltage Switchgear, RTU Terminal LV metering, HV Metering APFC Panel and capacitor bank with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from the 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. 11KV Isolators controls incoming and outgoing feeder cables of the 11KV distribution system. 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, Bus bar, outgoing switch. The connection LT cables to distribution feeder pillar/consumer shall be taken out from the Low Voltage switchgear.

4.2 The prefabricated package substation shall be designed for

- Compactness,
- Fast installation,
- Maintenance free operation,
- Safety for worker/operator & public,

4.3 The Switchgear and components of Package Substation shall be capable of withstanding all types of Stresses whether mechanical or electrical or developed due to short circuits without any damage or deterioration of the materials.

4.4 For continues operation at the specified ratings, temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard.

5.0 Specific Requirement:

5.1 The main components of a prefabricated package substation are Transformer, High-voltage switchgear and control gear, Low-voltage switchgear and control gear and corresponding interconnections (cable, flexible, bus bars) & auxiliary equipment.

5.2 The components shall be enclosed, by either common enclosure or by an assembly of enclosure.

5.3 All the components shall comply with their relevant IEC and Indian standards.

5.4 Ratings:

Description	Unit	Value
Rated Voltage / Operating Voltage	kV rms	12/11

Rated frequency & Number of phases	Hz & nos.	50 & 3
Rated power of the substation	KVA	**315/500/630/1000 KVA Cast ResinDr y type**
Rated Ingress protection class of the enclosure	IP	IP-34 for Transformer Compartment and IP: 54 for LT & HT Switchgear Compartment.
Rated temp Class of Transformer Compartment		K10
HV Insulation Level		
Rated withstand voltage at power frequency of 50 Hz	kV rms	28
Rated Impulse withstand Voltage	kV peak	75
HV Network & Bus bar		
Rated current	Amp	630A
Rated short time withstand current	kA rms / 3 sec	20
Making capacity for switch-disconnector & earthing switches	kA peak	50Ka
Breaking capacity of Isolators (rated full load)	A	630A

6.0 SPECIFICATIONS FOR ENCLOSURE:

6.1 The outdoor enclosure shall be made of galvanized Sheet Steel suitable for local weather conditions

6.2 The enclosure shall be of a partially modular design of GI sheets fastened by riveting.

6.3 The thickness of the enclosure shall be 1.5 mm for non load bearing members & 2mm for load bearing members.

6.4 The enclosure shall be powder coated / Wet Polyurethane paint.

6.5 The protection degree of the Enclosure shall be **IP 54 for LT & HT switchgear compartment & IP 34 for Transformer compartment.** Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.

6.6 The metal base shall ensure rigidity for easy transport & installation.

6.7 The substation will be used in outdoor application, hence to prevent the enclosure from rusting/corrosion, welding should be avoided.

6.8 Considering the outdoor application of the substation the doors shall be provided with proper interlocking arrangement for safety of the operator and to avoid corrosion, doors should have stainless steel hinges. The Doors should be provided with stoppers.

6.9 Interconnection between HT switchgear and transformer shall be using aluminum unarmored XLPE insulated PVC sheathed cable and between transformer and LT switchgear shall be using Busbar/Aluminum unarmored XLPE insulated PVC sheathed cable.

6.10 **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 IEC61330/62271-202.

6.11 Type test report of arcing due to internal fault should submit with the offer. The Package substation shall be tested for internal arc test –AB for 20KA for 1 sec (A-operator, B-pedestrian)

6.12 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 90^0 & be equipped with a device able to maintain them in an open position. **The doors shall be a 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**

6.13 **Earthing**: All metallic components shall be earthed to a common earthing point and transformer neutral point to be separate by chemical earthing. 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.

1.13.1 The enclosure of Compact Package substation,
1.13.2 The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
1.13.3 The metal screen & the high voltage cable earth conductor,
1.13.4 The transformer tank or metal frame, of transformer,
1.13.5 The frame or enclosure of low voltage switchgear,
1.13.6 The neutral point of transformer

6.14 There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

6.15 **Labels**: Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.

6.16 **Cleaning & Painting:**

6.17 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 polyurethane paint/ Powder coated**

PART-2: 11KV Ring Main Unit (RMU) Indoor/Outdoor

1.0 SCOPE:

This specification covers Design, Engineering, Manufacture, Assembly, Stage testing, Inspection, Testing before supply, packing and delivery at stores of 11 KV Ring Main Units fully motorized SCADA compatible extensible type (Outdoor) comprising 2 numbers Load break Isolators and one Circuit breaker for Distribution Transformer protection. The Unit should be extensible for future requirement. The RMU to be supplied against this specification are required for vital installations where continuity of service is very important. The design, materials and manufacture of the equipment shall, therefore, be of the highest order to ensure continuous and trouble-free service over the years. The RMUs should be provided with necessary terminal blocks which shall be used for connecting the RTUs for automation.

The RMU offered shall be compact, maintenance free, easy to install reliable, safe and easy to operate and complete with all parts necessary for their effective and trouble-free operation. Such parts will be deemed to be within the scope of the supply irrespective of whether they are specifically indicated in the commercial order or not. The bidder should have the assembly, welding and testing facility for manufacturing RMUs in India and have a vast service facility in country.

The performed TYPE TESTS and ARC FAULT TESTS must be proved by documents of independent & selected test facilities / centers or test houses. (KEMA, CESI, etc.)

It is not the intent to specify herein complete details of design and construction. The offered equipment shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. In actual practice, notwithstanding any anomalies, discrepancies, omissions, in-completeness, etc. in these specifications, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. as are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, I.E. Rules, I.E. Act and other statutory provisions.

The Tenderer/supplier shall bind himself to abide by these considerations to the entire satisfaction of the purchaser and will be required to adjust such details at no extra cost to the purchaser over and above the tendered rates and prices.

Tolerances: Tolerances on all the dimensions shall be in accordance with provisions made in the relevant Indian/IEC standards amended up to date and in this specification. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

Recommended spares:

The bidder shall furnish in his offer a list of recommended spares with unit rates for each set of equipment that may be necessary for satisfactory operation and maintenance of circuit breaker and Isolators for a period of 5 years. The purchaser reserves right of selection of items and quantities of these spares to be ordered. The cost of such spares shall not be considered for tender evaluation.

SCADA compatibility

The RMUs shall be suitable for remote operation i.e. it shall be possible to have Motorized operation of both the Load Break Isolators. The RMU should be provided with provision of necessary terminal blocks which shall be used for connecting the RTUs for automations.

The RMU should have compatibility with OPEN PROTOCOL SCADA system and suitable to indicate ON /OFF position of LBS & CB, Earth Switch, Gas pressure VPU and FPI indication etc.

Erection and maintenance tools:

The bidder shall submit a list and unit rates of all the special tools, equipment and instruments required for erection, testing, commissioning and maintenance of the equipment. The purchaser shall decide the quantity of tools to be ordered. Prices of these tools shall not be considered for tender evaluation. However, the list of necessary tools/equipment which will be supplied free of cost with each Ring Main Unit may be furnished separately.

Preferred Makes of Transformer – Schneider / ABB / Siemens / Raychem / Volt amp / CG/C&S

2.0 APPLICABLE STANDARDS:

Unless otherwise specified elsewhere in this Specification, the RMU, Switchboard (Switchgear), Load break isolators, Instrument Transformers and other associated accessories shall conform to the latest revisions and amendments thereof of the following standards.

1.	IEC 62271-200/IS 12729:1988	General requirement for Metal Enclosed Switchgear
2.	IEC62271-102/IS 9921	AC disconnector's (Load Break Isolators) and Earthing Switch.
3.	IEC 62271-100 / IEC 62271-200	Specification for alternating current circuit breakers
4.	IEC 62 271-1	Panel design, SF6/Vacuum Circuit Breakers
5.	IEC60044-1/IS2705:1992	Current Transformer
6.	IEC 60265/IS 9920:1981	High voltage switches
7.	IEC 60376	Filling of SF6 gas in RMU
8.	IEC 60273/IS :2099	Dimension of Indoor & Outdoor post insulators with voltage > 1000 Volts
9.	IEC 60529/IS 13947(Part-1)	Degree of protection provided by enclosures for low voltage switchgear and control gear.
10.	IS 3043-1987	Code of Practice for earthing
11.	IEC 60255	Electrical Relays
12.	IEC 60376 :	Filling of SF6 Gas in RMUs

Indian Electricity Rules/Bills

All Indian Electricity Rules/ Bills amended up to date applicable for clearances, safety and operation of the equipment.

The RMU meeting with the requirements of any other authorities standards, which ensures equal or better quality than the standard mentioned above shall also be acceptable. If the

equipment, offered by the bidder conform to other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail. One copy of such standards with authentic English Translations in Hard Copy shall be furnished along with the offer.

3.0 SERVICE CONDITIONS:

All outdoor Equipment / material to be supplied against this specification shall be suitable for satisfactory continuous operation under tropical conditions as specified below:

- Maximum ambient air temperature in shade 50^0C
- Minimum ambient temperature in shade -2.5^0C
- Maximum Relative humidity 95%
- Minimum Relative humidity 10%
- Average Annual rainfall 10-100 Cm.
- Maximum wind pressure (Kg. Per sq. m.) 45
- Height above mean sea level < 1000 Meter
- Dust storms are liable to occur during the period March to July
- Average number of rainy days per annum 100
- Isoceraunic level (days / year) 40
- Moderately hot and humid tropical, climate, Conductive to rust and fungus growth Yes
- Seismic level (horizontal acceleration) 0.08 g

4.0 General Requirement:

The motorized Ring Main Unit shall be installed at 11 kV Junction/T-OFF points where HT lines are terminated. The RMUs should be provided with necessary terminal blocks which shall be used for connecting the RTUs for automations. The RMU shall be extensible type for future add-on facilities. Two Load break isolators for incoming & outgoing cables and one Circuit breaker for transformer protection shall be enclosed in the main tank using SF6 gas as both insulating and arc quenching medium. The main tank shall be made of suitable stainless steel sheet of adequate thickness or earth screened cast iron resin. The stainless steel tank shall be robotically MIG/ TIG welded with a pressure relief arrangement. The tank should be tested in factory for a leak rate of 0.1% per year. Both the load break switches shall be motor/manual operated with the arrangement of power pack source as integral part. The total breaking time for transient fault should not exceed 40-60 mS (C B + Relay+ trip coil). The main tank (Inner enclosure of Circuit Breaker & Load break Isolators assembly) and all Switchboard assembly shall be housed in a single compact metal clad suitable for both indoor/outdoor applications.

The design of enclosure for Switchgear, RMU & Switchboard housing shall be in accordance with IEC 298.

Motor is to be provided for spring charging mechanism along with suitable Battery / Power Pack and its charger.

The switchgear and switchboard shall be designed such that the position of the different devices shall be visible to the operator on the front of switchboard and easy to operate and prevent access to all live parts during operation without the use of tools. There shall be no access to exposed conductors.

An absorption material such as activated alumina in the tank shall be provided to absorb the moisture from the SF6 gas to regenerate the SF6 gas following arc interruption. A temperature compensating gas pressure indicator offering a simple indication shall constantly monitor the SF6 insulating medium.

Sulphur Hexa Fluoride Gas (SF6 GAS):
The SF6 gas shall comply with IEC 376,376A and 376B and shall be suitable in all respects for use in RMUs under the stipulated service conditions. The SF6 shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC 376,376A and 376B and test certificate shall be furnished to the owner indicating all the tests as per IEC 376 for each Lot of SF6 Gas.

5.0 Configurations recommended:

Extensible RMU with one number of 630A circuit breaker and two Loads break isolators with earth isolator arrangement having provision for adding more breaker and isolators on either sides depending upon the requirement of site locations.

6.0 ENCLOSURE:

6.1 Outer Enclosure:
The RMU enclosure (Outer) shall be made up of CRCA of adequate thickness. The rating of enclosure shall be suitable for operation on three phases, three wires, 11 KV, 50 cycles, A.C. System with short-time current rating of 20KA for 3 seconds for 11kV supply with Panels. The complete RMU enclosure shall be of degree of protection IP 54.

The enclosure shall provide full insulation, making the Switchgear insensitive to the environment like temporary flooding, high humidity etc. The active parts of the Switchgear shall be maintenance-free and the unit shall be minimum -maintenance.

The complete RMU unit shall be powder coating of Dark Grey Code 632 as per BS 381C or as per client requirement. Each switchboard shall be identified by an appropriately sized label which clearly Indicates the functional units and their electrical characteristics.

The Switchgear and Switchboards shall be designed such that the position of the different devices is visible to the operator on the front of the Switchboard and operations are visible.

In accordance with the standards in effect, the switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools.

The RMU metal parts shall be made of high thickness high tensile steel. Thermally sprayed with Zinc alloy (not for galvanized), phosphate and subsequently painted with Polyurethane based powder paint, the overall (including outer and inner paint layer), the thickness of paint layer shall be not less than 150 microns.

Inner enclosure (Main tank)

The main tank shall be made of suitable stainless steel sheet of adequate thickness or earth screened cast iron resin. The stainless steel tank shall be robotically **Metal Inert Gas (MIG)/ Tungsten Inert Gas (TIG)** welded stainless steel sheet of adequate thickness. The tank shall be sealed and no handling of gas is required throughout the 30 years of service life. However, the SF6 gas pressure inside the tank shall be constantly monitored by a temperature compensating gas pressure indicator offering a simple go, no-go indication on the front side of the panel. The gas pressure indicator shall be provided with green pressure and red pressure zones. There shall be one Non – return valve to fill up the gas. The manufacturer shall give guarantee for maximum leakage rate of SF6 gas will be lower than 0.1 % / year. An absorption material such as activated alumina in the tank shall be provided to absorb the moisture from the SF6 gas to regenerate the SF6 gas following arc interruption. The degree of protection of the inner enclosure shall be IP 67.

Oil or Air filled Switchgear will not be considered. The temperature rise test shall be carried out on complete RMU unit and test reports shall be submitted with the offer.

The compact RMU Unit shall be provided with a pedestal made up of M.S. Angle to mount the unit on plain surface. The height of the bottom of cable box shall be 310 mm minimum to provide the turning radius for the HT cable termination.

7.0 BUSBARS:

The three Nos of continuous Bus bars made up of EC grade tinned copper of rating current 630A shall be provided. The Short circuit time rating current shall be 20 kA for 3 seconds for 11 kV.

8.0 Load Break Switches (Isolators)

The Motorized/Manual Load Break Isolators for Incoming and Outgoing supply must be provided and the load break isolators are fully insulated by SF6 gas. The isolator must be fitted with snap action drives/mechanisms. The operating mechanism shall be spring assisted mechanism with operating handle for ON /OFF. Earth positions with arrangement for padlocking in each position. Also independent manual operations with mechanically operated indicator. All the mechanical interlocking must also work when the isolator are operated by motor drive. The earth switch shall be naturally interlocked to prevent the main and earth switch being switched 'ON' at the same time. The selection of the main and earth switch is made by a lever on the facia, which is allowed to move only if the main or earth switch is in the off position. The load break isolators should have the facility for remote operation. Each load break switch shall be of the triple pole, simultaneously operated, non-automatic type with quick break contacts and with integral earthing arrangement. The rated current of Isolator shall be 630 Amps continuous at maximum ambient temperature. No De-rating shall be allowed for the isolator at an ambient temperature of 50°C, which means that Isolator rating should be 630A maximum at ambient temperature of 50°C. The relevant type test

report to prove the temperature rise below 55°C shall be submitted by the bidder with the offer. Motor is to be provided for spring charging mechanism along with suitable Battery / Power Pack and its charger.

The technical particulars of the isolator are:-

1	Construction per phase	SF6-Single Break
2	Current Capacity	630A
3	Making Capacity	50 KA(peak)
4	Breaking capacity normal load current	630A
5	Short time rating	20 KA for 3 second
6	Short circuit current making capacity	50 KA
7	Impulse withstands voltage to earth between poles.	75 kV peak
8	Power frequency withstand voltage to earth and between	28kV RMS for 1 min
9	Electrical class of operation	E3
10	Operating Mechanism for close / open	Electrically operated with motor mechanism
11	Manual operation of LBS with/without removal of motor shall be possible	Possible with/ without removal of motor
12	Minimum number of operations at rated current as per IEC 60265	To be guaranteed by firm along with test certificate
13	Minimum number of operations at fault current as IEC	Same as above
14	Spring charge Motor	D.C. Motor 24/48 volts
15	Re-chargeable Battery Pack for Motor	24/48 volt D.C.
16	Charger for Battery Pack	A.C.240V; 50Hz. of suitable

9.0 EARTHING SWITCH:

The unit shall consist of a 630 Amp Tee Off spring assisted three position rotating arc type SF6 circuit breaker unit, with integral fault making/dead breaking earth switch, the function shall be naturally interlocked to prevent the main and earth switch from being switched `ON` at the same time. The selection of the main/earth switch lever on the facia, which is allowed to move only if the main or earth switches in the off position. The direction of rotation must be clockwise when switching ON and counterclockwise when switching OFF the earthing switch. The lever may be padlocked in either the main or earth position.

The cables shall be earthed by an integral earthing switch with short-circuit making capacity, in compliance with IEC 129 standard. The earthing switch shall be operable through the main circuit mechanism and manual closing shall be driven by a fast-acting mechanism, independent of operator action.

10.0 CIRCUIT BREAKER

The 3 pole circuit breaker for the protection of Distribution transformers shall be enclosed in the main tank. The rated breaking and making current at rated voltage shall be as follows: Rated

breaking capacity shall be 20 kA for 3 second. Rated making current shall be 50 kA for 3 second. The drives/ mechanisms for VCB should be fitted with the stored energy release for tripping.

The manual operation of the circuit breaker shall not have an effect on the spring charging mechanism. The circuit breaker shall be fitted with a mechanical flag, which shall operate in the event of fault occurrences. The breaker indications ON and OFF positions shall be indicated by suitable flag. For ON position indication by Red flag and OFF position indication by Green flag shall be provided.

The circuit breaker shall be operated by the same unidirectional handle or switch.

Motor is to be provided for spring charging mechanism along with suitable Battery / Power Pack and its charger.

The circuit breaker unit fitted with 3 Nos protection CT's (tape wound/epoxt cast) of ratio 100-50A/1A, 10P10 class, having sufficient VA burden for trip coil and auxiliary switch assembly allowing the use of a self- powered non directional IDMT (Inverse Definite Minimum Time) Over Current and Earth Fault Relays (Microprocessor based). One microprocessor based communicable numerical relay having three O/C elements and one E/F element shall be provided for this purpose. The relays shall be of 3 seconds IDMT characteristics, the O/C elements current setting should be variable. A facility of provision for the delay of transformer in-rush current shall be provided on relay to avoid nuisance tripping.

The technical particulars of the Circuit Breaker are:-

1	Construction	SF6/Vacuum
2	Current capacity	630A
3	Rupturing capacity	20KA
4	Making capacity	50 KA
5	Short time rating	20kA for 3 Sec.
6	Impulse flashover withstand voltage	75kV peak
7	Power frequency withstand voltage	28kV (rms)

Current Transformer

1	No. Of cores	1
2	Class of accuracy	10P10 & 1
3	Core 1 (protection)	10P10
4	CT ratio	100-50/1A

11.0 Protection:

Suitable protection equipment like self-powered numerical relay with one trip coil for protecting the consumer's installation shall be provided.

1	Power frequency withstand Voltage	28kV (rms)
2	Impulse flash over withstand	75kV (peak)

3	Operating mechanism	Motor / Manual spring charged stored energy type
4	Spring charge Motor	D.C. Motor 24/48 volts
5	Breaker status Auxiliary contacts	2 NO+2NC Wired to terminal block
6	Minimum number of operations at rated current as per IEC 62271	To be guaranteed by firm along with test certificate
7	Minimum number of operations at fault current as per IEC 62271	Same as above
8	Re-chargeable Battery Pack for	24/48 volt D.C.
9	Charger for Battery Pack	A.C.240V, 50Hz. of suitable Amp. Capacity.
10	Protection Relay	Self-powered microprocessor based communicable Numerical relay
11	Relay Auxiliary contacts for remote	Potential free, 1NO+1NC wired to terminal block
12	Explosion vents	To ensure operator's safety any Gas / flames generated during flash over / blast in any of the compartment must not come out from the front of RMU.
13	The circuit breakers shall be provided with interlocked disconnector and earth Switch. Earthing switch should be of full fault making capacity (20 kA).	

12.0 WIRING & TERMINALS:

The wiring should be of high standard and should be able to withstand the prevailing weather conditions. All the wiring and terminals (including wiring to the terminal blocks which will be in future connected to RTUs for automation, DC, Control wiring), Spare terminals shall be provided by the supplier. The wiring cable must be standard single- core non-sheathed, Core marking (ferrules), stripped with non-notching tools and fitted with end sleeves, marked in accordance with the circuit diagram with printed adhesive marking strips. All wiring shall be provided with single core multi-strand copper conductor wires with FRLS PVC insulation.

The wiring shall be carried out using multi-strand copper conductor super flexible FRLS PVC insulated wires of 1.1KV Grade for AC Power, DC Control and CT circuits. Suitable coloured wires shall be used for phase identification and interlocking type ferrules shall be provided at both ends of the wires for wire identification. Terminals should be suitably protected to eliminate corrosion. Connections and terminal should be able to withstand vibrations. The terminal blocks should be stud/screw type for controls and disconnecting link type terminals for CT leads with suitable spring washer and lock nuts.

Flexible wires shall be used for wiring of devices on moving parts such as swinging Panels (Switch Gear) or panel doors. Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals, terminal blocks and wiring gutters. The cables shall be uniformly bunched and tied by means of PVC belts and carried in a PVC carrying trough.

The position of PVC carrying trough and wires should not give any hindrance for fixing or removing relay casing, switches etc., Wire termination shall be made with solder less crimping type of tinned copper lugs. Core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted with both ends of each wire. Ferrules shall fit tightly on the wire when disconnected. The wire number shown on the wiring shall be in accordance with the IS.375.

All wires directly connected to trip circuits of breaker or devices shall be distinguished by addition of a red colour ferrule.

Inter-connections to adjacent Panels (Switch Gear) shall be brought out to a separate set of Terminal blocks located near the slots or holes to be provided at the top portion of the panel. Arrangements shall be made for easy connections to adjacent Panels (Switch Gear) at site and wires for this purpose shall be provided and bunched inside the panel. The bus wire shall run at the top of the panel. Terminal block with isolating links should be provided for bus wire. At least 10% of total terminals shall be provided as spare for further connections. Wiring shall be done for all the contacts available in the relay and other equipment and brought out to the terminal blocks for spare contacts.

Color code for wiring is preferable in the following colors.

Voltage supply	Red, Yellow, Blue for phase and Black for Neutral
CT circuits	Similar to the above
DC circuits	Gray/Black for both positive and negative
Earthing	Green

The wiring shall be in accordance to the wiring diagram for proper functioning of the connected equipment. Terminal blocks shall not be less than 650V grade and shall be piece-molded type with insulation barriers.

The terminal shall hold the wires in the tight position by bolts and nuts with lock washers. The terminal blocks shall be arranged in vertical formation at an inclined angle with sufficient space between terminal blocks for easy wiring.

The terminals are to be marked with the terminal number in accordance with the circuit diagram and terminal diagram. The terminals should not have any function designation and are of the tension spring and plug-in type.

13.0 INTERLOCKS:

Necessary arrangements are provided at Load break isolators / Distribution Transformer Breaker for selecting Earth position. Mechanical interlocking systems shall prevent the RMU function from being operated from the ‘ON’ to ‘Earth On’ position without going through the ‘OFF’ position. In addition to interlocking that prevents access into compartments, the following interlocking shall be provided.

1. Operation of load break isolator / disconnector of circuit breaker cannot be performed when the

    - Load Break Isolator /Circuit breaker is padlocked.
    - Earthing switch is in the closed position.
2. Operation of an earthing switch cannot be performed when the load Break Isolator/circuit breaker is in closed position

3. Suitable interlocks shall also be provided so that Cables compartment covers can be open only in circuit 'Earth On' position.

Note: Suitable indications for 'ON', 'Earth ON', 'OFF' and padlocking should be provided.

14.0 BUSHINGS:

The units should be fitted with the standardized bushings that comply with IEC standards. All bushings should be at the same height from the ground and are protected by a cable cover. The bushings should be made up of epoxy and should contain an inner metal screen capable to be connected to capacitive voltage indicating system for indicating the presence of voltage at the bushings.

The rated current caring capacity and short-time withstand capacity of the bushing should be same as that of the breaker / isolator i.e. 630 Amp. The same should be proved with calculation and necessary type test reports, like temperature rise and STC. The bushing should be of non-removable type so as to reduce the leakage and theft at site. The bushing should have M16 treaded conductor.

15.0 CABLE BOXES:

All the cable boxes shall be air insulated suitable for heat shrinkable type cable terminations. The cover of the cable boxes should be easily removable type so as not to provide any hindrance to the persons during the cable termination and maintenance. It should be designed to have five point locking arrangement to withstand the internal arc pressure. The cable boxes should not be of bolted construction/type as this will lead to an increase of restoration time during the process of maintenance, which is undesirable. The access to the cable box should be from front only. The side & rear access to the cable boxes not acceptable as this increases the installation & operational space area at the site.The cable boxes of ring switches shall be suitable for accepting 3 CORE HV cables of assorted sizes up to 300 Sq mm. Necessary PUSH-ON type Right angle Boot should be supplied along with RMUs to be placed on the cable terminations points to avoid the flash-over between the phases. The test reports for the right angled cable boots duly mounted on the RMU bushings has to be submitted by the vendor to prove that the clearances between the bushings are sufficient. Compound filled cable boxes are not acceptable. The cable box shall be arc resistant as per IEC 62271-200 amended up to- date. The internal arc fault test on cable box shall be carried out for 11 kV systems for 20 kA for a minimum of 0.1 second. The cable bushing and clamp arrangements shall be appropriate for the type and style of cables used at the time.

The Terminations should be provided by the contractor at the following places in RMU.

- Incoming cable to Isolators: Indoor Type
- Outgoing cable from Isolators: Indoor Type
- Outgoing cable from Breaker to DT HT bushings: Indoor Type
- For DT HT side cable. Outdoor Type

The Indoor type termination kits should be suitable for fixing in RMUs. The terminations shall be Heat **shrinkable type.** Necessary suitable clamps shall be provided. The quantity and size of termination are indicative however the requirement based on the site condition shall be met.

16.0 CABLE TESTING FACILITY:

It shall be possible to test the cable with opening the cable box covers but without disconnecting the cables in both the cases the isolator and the breaker. Further, the cable testing for transformer feeder should even be possible when the bus bars are live.

16.1 TESTING OF CONNECTED CABLES: It shall be possible to carry out HV DC test on the connected cable at site, keeping only the corresponding Isolator / Circuit Breaker OFF but keeping Bus bars /other circuits alive at the rated voltage. The bushings in the cable boxes shall be easily accessible so that the fore mentioned HV DC test can be carried on each phase separately without any hindrance.

17.0 VOLTAGE INDICATOR LAMPS AND PHASE COMPARATORS

The RMU shall be equipped with a voltage indication system as per IEC 601958/61243-5 to indicate whether or not there is voltage on the cable. There should be a facility to check the synchronization of phases with the use of external device. It shall be possible for the each of the function of the RMU to be equipped with a permanent voltage indication.

The capacitive dividers will supply low voltage power to indicator which shall have LCD/LED for indication of Voltage presence on the cable bushings. Indicators with external lamps shall not be acceptable as they are prone for theft.

Three outlets can be used to check the synchronization of phases with the use of an external device.

18.0 PROTECTION WHEN OPERATING & WORKING:

The safety of the work man while working and operating must be ensured. The following protection categories must be met in order to protect one from **direct touching** of live parts according to IEC 60298.

- IP3X for the drives & the secondary equipment
- IP67 for the main circuits

To protect one from the effects of an internal fault, the switchgear alone with cable box must be type-tested for internal arc at 20kA for 1 Second. The protection rating below this is not acceptable. It is to ensure the maximum safety of the switchgear.

19.0 FAULT PASSAGE INDICATORS (FPI):

These shall facilitate quick detection of faulty section of network / feeder. 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 each RMU and shall be capable of indicating the fault. The FPI shall have LED display and manual as well as remote reset facility. It shall also have potential free contacts for SCADA. FPIs should sense both short circuit fault and earth fault separately. FPIs

should have multiple ampere and time settings both for short circuit and earth fault in addition to multiple auto resetting time ranging from 2 hrs to 8 hrs. The sensing shall be either through 3 nos. of phase sensors or 3nos. of phase sensors with additional earth fault sensor (CBCT).

20.0 EARTHING:

Earthing should be in accordance with the IS 3043-1987, Code of Practice for Earthing. The RMU outdoor metal clad, Switch Gear, Load break isolators, etc., shall be equipped with an earth bus securely fixed along the base of the RMU. The earth point will be connected to ground earth pit.

When several units of the RMU (Extra Isolators / Breakers) are mounted adjoining to each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. The size of the earth bus shall be made of IEC/IS standards with **tinned copper flat for RMU.** Provision shall be made on end of RMU for connecting the earth bus to the earth grid. Necessary terminal clamps and connectors shall be included in the scope of supply. In case of RMUs made of GI, the body itself can be considered at earth potential and necessary connecting points for earthing the RMU & cable shield shall be provided.

All metal parts of the switchgear which do not belong to main circuit and which can collect electric charges causing dangerous effect shall be connected to the earthing conductor made of GI having CS area of minimum 75 Sq. mm. Each end of conductor shall be terminated by M12/equivalent quality and type of terminal for connection to earth system installation. Earth conductor location shall not obstruct access to cable terminations.

The following items are to be connected to the main earth conductor by rigid or flexible copper conductors / wires having appropriate desirable cross section for caring the maximum current under fault conditions

- The tank containing the load break switches, circuit breaker & earthing switches
- Cable sheath or screen.
- All metallic cases of the relays, instruments and other panel mounted equipment. The colour code of earthing wire shall be green. Earthing wires shall be connected on the terminals with suitable clamp connectors and soldering shall not be permitted.

21.0 OTHER ACCESSORIES:

The following spares and accessories shall be supplied along with the main equipment at free of costs. This shall not be included in the price schedule.

- Charging lever for operating load break isolators & circuit breaker of each RMU
- Operation & Maintenance manual – 1 No per RMU.
- Installation & Commissioning manual – 1 No per RMU.

Provision shall be made for padlocking the load break switches/ Circuit breaker, and the earthing switches in either open or closed position.

22.0 GUARANTEED TECHNICAL PARTICULARS:

The technical particulars as per IEC shall be guaranteed and Guaranteed Technical Particulars shall be furnished as per Annexure enclosed by the Bidder along with the bid.

23.0 TECHNICAL PARAMETERS

I. 11KV Bus Bar

1	Type of material	Copper
2	Current Carrying Capacity	**630 Amps.**
3	Short time rating current for 3 secs.	20 KA
4	Insulation of bus bar	SF6
5	Bus bar connections	Anti-oxide grease

II. Parameters for Switch Gear of DT and load break isolators

1	Type	Metal enclosed
2	No of Phases	3
3	No. of poles	3
4	Rated voltage	12 KV
5	Operating voltage	11 KV(+10% to –20%)
6	Rated lightning impulse withstand voltage	**75 KV**
7	Rated power frequency withstand voltage	28 KV
8	Insulating gas	SF6
9	Rated filling level for insulation	0.3 bar/As Per relevant IS/IEC Code
10	Maximum Permissible site altitude at the above gas pressures (The operating pressure has to be adjusted for greater altitudes)	1000m
11	Rated short time current	20 KA.
12	Rated short time	3s
13	Rated peak withstand current	50 KA
14	Operating mechanism	Circuit breaker with spring assisted anti reflex mechanism.
15	Rated current (Bus)	630**A**
16	Rated current (breaker)	**630A**
17	Circuit Breaker interrupter	**VCB**
18	Rated frequency	**50 Hz**
19	Rated operating sequence	**O-3min- CO -3min-CO**

Number of mechanical/Remote operations for earthing & Ring switches & Number of mechanical/ remote operations for circuit breakers as per IEC 60298

III. PRINCIPAL FEATURES:

Sl. No.	DESCRIPTION	DT Breaker

1	Circuit label	Yes
2	Mimic diagram	Yes
3	Supply voltage indication	Yes
4	Current Transformer	Yes
5	Self-Powered based Microprocessor based communicable IDMT	Yes
6	Interlock for non-operation of line side earthing when the line side	Yes
7	Interlock for non-operation of the earthing when the breaker is in service position and is ON. (With disconnector in ON condition)	Yes
8	Local /Remote Switch (In case of motorized RMUs only)	Yes
10	Breaker ON/OFF indication	Yes
11	Fault Tripping indication	Yes
12	Bus bar end caps	Yes
13	The SF6 gas pressure gauge indicator and filling	Yes
14	The spring assisted mechanism with operating handle for	Yes
15	The earth positions with arrangement for padlocking in each position and independent manual operation with mechanically operated indicator are provided	Yes
16	Status signals to SCADA to be wired to marshaling terminal	Yes
17	LBS close /open (potential free contacts)	Yes
18	LBS& CB Earth Switch close /open (potential free contacts)	Yes
19	Battery charger Fails (potential free contacts)	Yes
20	CB close /open (potential free contacts)	Yes
21	Protection relay operated (potential free contacts)	Yes
22	FPI operated (potential free contacts)	Yes
23	SF6 gas pressure Low (potential free contacts)	Yes
24	Commands from SCADA to be wired to marshaling	LBS close/ open, FPI reset etc.(For other details please see Automation Philosophy)

IV. Load break switch (Isolators):

1	Type	SF6 load breaking and fault making.
2	Rated current	630 A
3	Fault making capacity (KA peak min.)	50 KA
4	Auxiliary contacts	1NO+1NC wired to terminal block

V. Earthing switch for LBS & CB (11 KV Line side Isolation and DT):

- Rated short time current: 20 KA.
- Rated short time : 3s
- Rated peak withstand current : 50 KA
- Interlocking facility:
  - Between 11 KV Line side isolator 'ON"& Earthing.
  - Between 11 KV DT side breaker on close condition & Earthing.
  - Between breaker & disconnector on breaker function

- Auxiliary contacts :2NO+2NC wired to terminal block

24.0 TESTS:

24.1 TYPE TEST:

The bidder should, along with the tender documents, submit copies of all Type test certificate not older than 5 years of their make in full shape as confirming to relevant ISS/IEC of latest obtained from a Govt. Lab/International Recognized laboratory/KEMA/CESI.

- Impulse Test with breaker inside the cubical.
- Arc Fault Test
- Temperature rise test with breaker inside the cubical
- Short Circuit Test with breaker inside the cubical
- Dielectric Tests
- Test of Apparatus i.e. Circuit Breaker, Load Breaker Switch & Earthing Switches

24.2 ACCEPTANCE AND ROUTINE TESTS:

All acceptance and routine tests as stipulated in the latest IEC shall be carried out by the supplier and to be witnessed by the USCL nominated inspecting officer.

24.3 ROUTINE TESTS: (As per IEC-60298 standard)

- Withstand voltage at power frequency for all current carrying parts including wiring.
- Measurement of resistance of the Main circuit.
- Gas leakage Test.
- Partial Discharge test.
- Withstand voltage on Auxiliary Circuit.
- Operation of Function Locks, interlocks, Signaling Devices and Auxiliary Devices.
- Suitability & correct operation of Protection, Control Instruments and electrical connections of the circuit breaker operating mechanism (Primary & Secondary Injection).
- Verification of Wiring.
- Visual Inspection.

24.4 Mandatory Facilities which the vendor must posses

- Micro-ohm and circuit breaker testing via computerized analyzer machine.
- Computerized SF6 filling and testing facility.
- Partial Discharge lab for conducting the partial discharge and high voltage test on the complete product. It is mandatory to have the complete assembled tank tested for partial discharge to ensure a high life and reliably of the product.

25.0 PRE-COMMISSIONING TESTS:

The supplier has to arrange all the pre-commissioning tests in the presence of the USCL testing engineer and necessary drawings, manual and periodical test tools shall be arranged and supplied. The above tests are the responsibility of the contractor till the RMUs are put in to service.

26.0 STAGE INSPECTION:

The inspection may be carried out by the USCL at any stage of manufacture. The supplier shall grant free access to USCL representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the USCL shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

The supplier shall keep the USCL informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The USCL reserves the right to insist for witnessing the acceptance/routine testing of the bought out items.

The USCL has rights to inspect the supplier's premises for each and every consignment for type & routine test. The cost towards transport, stay and other expenses shall be borne by the supplier. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested / unless the same is waived by the USCL in writing.

27.0 NAME PLATE:

Each RMU and its associated equipment shall be provided with a nameplate legible and indelibly marked with at least the following information.

- Name of manufacturer
- Type, design and serial number
- Rated voltage and current
- Rated frequency
- Rated symmetrical breaking capacity
- Rated making capacity
- Rated short time current and its duration
- Purchase Order number and date
- Month and Year of supply
- Rated lighting impulse withstand voltage
- D.C. component of current.
- Feeder name (Incoming and Outgoing), DTs Structure name, 11000Volts Dangers etc.

NOTE:

- The word rated need not appear on the name plate. Recognized abbreviations may be used to express the above particulars.
- Whether the circuit breaker is fitted with closing / tripping devices necessitating an auxiliary supply shall be stated either on the circuit breaker name plate or any other acceptable position.

TRAINING:

The supplier shall give rigorous training to at least 15 Engineers & staff at the site in attending trouble shootings and maintenance. The cost towards transport, food and other expenses shall be borne by the supplier.

TROPICALISATION:

Due regard should be given to the climatic conditions under which the equipment is to work. Ambient temperature normally varies between 02 deg C and 50 deg. C, although direct sun temperature may reach 55 deg C. The climate is also moderately humid and rapid variations occurs, relative humidity between 70% and 95% being frequently recorded, but these values generally correspond to the lower ambient temperatures. The equipment should also be designed to prevent ingress of vermin, accidental contact with live parts and to minimize the ingress of dust and dirt. The use of materials which may be liable to attack by termites and other insects should be avoided**.**

PART-3 TRANSFORMER (CAST RESIN DRY TYPE)

1.0 Scope:

This specification covers the requirements of design, manufacture, testing and supply of cast resin dry type transformers complete with all the accessories and fittings for efficient and trouble-free operation.

Preferred Makes of Transformer – Schneider / ABB / Siemens / Raychem / Volt amp / CG

2.0 CODES & STANDARDS:

The equipment covered by this specification shall, unless otherwise stated to be designed, constructed and tested in accordance with latest revisions of relevant Indian standards / IEC publications.

IS 1271	-	Classification of Insulating Materials.
IS 2026	-	Power transformers (part I - V)
IS 2099	-	Bushing for alternating voltages above 1000 V
IS 2705	-	Current transformers
IS 3202	-	Code of practice for climate proofing
IS 3639	-	Power transformer fittings and accessories
IS 4257	-	Porcelain bushings for transformers
IS 11171	-	Dry type Transformer
IS 8478	-	Application guide for tap-changers
IS 10028	-	Code of practice for selection, installation and Maintenance of transformers.

3.0 GENERAL DESIGN FEATURES:

4.1 All transformers shall be of the latest design, dry type Cast Resin only.

4.2 The type of cooling shall be Natural Air cooled (AN) and the corresponding ratings for each transformer shall be as indicated in the specific requirements.

4.3 Each transformer shall be suitable for operation at full rated power on all tapings without exceeding the applicable temperature rise.

4.4 It shall be possible to operate the transformer satisfactorily, with the loading Guide specified in IS-6600. There shall be no limitations imposed by bushings, Tap changers, and auxiliary equipment to meet this requirement

4.5 The transformers shall be designed to be capable of withstanding, without damage , the thermal and mechanical effects of short-circuits between phases or between phase and earth at the terminals of any winding with full voltage applied across the other winding for periods given in relevant standards. The transformer/off load tap links should be able to meet the short circuit level specified (as mentioned in technical specification) without permanent damage.

4.6 Each transformer should be designed for minimum no-load and load losses within the economic limit and shall be able to have minimum loss at the rated load condition.

4.7 All electrical connections and contacts shall be of ample cross sections for carrying the rated current without excessive heating.

4.8 The transformer shall be capable of continuous operation at full load rating under the following conditions.

- Voltage variation = ± 10%
- Frequency variation = ± 5%
- Combined voltage and frequency variation (Absolute sum) = 10%

4.0 CONSTRUCTION:

4.1 The transformer shall be dry type, AN cooled suitable for Compact Package substation application.

4.2 The core-clamping frame shall be provided with lifting eyes having ample strength to lift the complete core and winding assembly.

4.3 Off circuit tapings shall be provided on the HV windings. Tap changing is done by means of off-circuit links accessible through openings provided.

4.4 The lifting lugs and rollers shall be provided. A winding temp. Scanner shall be provided and is actuated by means of resistance temperature detectors embedded in LV windings of all three phases. It should have alarm and trip contacts at a specified temperature.

4.5 The transformer shall be suitable to be installed in the transformer compartment of package substation having IP34 protection class.

5.0 WINDINGS:

5.1 The winding insulation shall be of Class ‘F” and temperature rise limit to Class F. i.e. 115 deg. C

5.2 Windings shall be of electrolytic copper conductors (circular in shape) of high conductivity and 99.9% purity.

5.3 Windings shall be designed to withstand the specified thermal and dynamic short circuit stresses.

5.4 The windings shall be duly sectionalized. Accessible joints brazed or welded and finished smooth shall connect similar sections. No corona discharge shall result on the winding upon testing the transformer for induced voltage test as specified in IS.
5.5 The end turns of the high voltage windings shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal condition.
5.6 The high voltage and low voltage winding are shall be made of copper Conductors. HV winding will be always be resin casted under vacuum while LV winding can either be casted or pre-impregnated with resin.

6.0 CORE:

6.1 The double wound Core shall be constructed from non-ageing cold rolled Grain oriented steel sheets. The built core shall be painted with high temperature resistant paint to prevent corrosion at the edges of core plates and to withstand high temperatures. By using different core material optimization of core losses shall be achieved. The yokes shall be firmly clamped between yoke channels or plates. The top & bottom yoke frames shall be secured to each other by means of tie-rods, which help in securing the winding in place.

6.2 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of flux component at right angles to the planes of laminations which may cause local heating.

7.0 OFF-CIRCUIT TAP CHANGING LINKS:

Off circuit tapings are provided on HV windings. Tap changing is done by means Off circuit links. Use of tap changing links eliminates any moving parts as against a manually operated tap changer.

7.1 Terminal Arrangement HV side and LV side of transformer will have the top bus bar arrangement for connection of HT side by means of cable and LT side by means of bus bar.

7.2 Technical particulars of dry type transformer

S. No	**DESCRIPTION**	**PARTICULARS**
01	Type	Three Phase, 50 Hz, Core type, two winding, Cast Resin Dry type Transformer
02	Make of transformer	Same as the maker of package substation
03	Rating (KVA)	315/500/630/1000 kVA
04	Winding material	Copper
05	No load voltage ratio	11 KV / 433 V
06	Connection a) HV b) LV	 Delta Star with neutral
07	Vector group	Dyn 11

09	Insulation level (KVp/ KVrms) a) HV b) LV	 75 / 28 -/ 03
10	Type of Tap Changer for giving voltage variation to HV	Off circuit tap links
11	Tapping range	+5 % to –5 % in step of 2.5%
12	Temperature rise winding over ambient temperature	115 °C
13	Class of Insulation	Class 'F'
14	Enclosure	IP 00 (Without Enclosure)
15	Method of Cooling	AN (Air Natural)
16	Max. No load losses at rated voltage & frequency (IS Tol)	Min. Watts
17	Max. Full load loss at principle tap at 75º C (IS Tol.)	Min. Watts
18	Termination HV LV	 Busbar Busbar
19	Fittings for Dry type	2 Numbers Earthing Terminals, Rating and Diagram Plate, Bi-Directional Rollers, Lifting Lugs, Winding Temp Scanner.
20	Paint	Enamel-RAL 7032

7.3 PAINTING:

7.3.1 All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents as required to produce a smooth surface free of scale, grease and rust.

7.3.2 The external surface, after cleaning, shall be given a cost of high quality red oxide or yellow quoted primer, followed by filler coats.

7.3.3 Routine Test, All Routine Tests in accordance with IEC 60076 / IS 2026 shall be carried out on each transformer.

8.0 NAMEPLATE:

Each transformer shall be provided with a nameplate of weather resistant material fitted in a visible position showing but not limited to the following item:

a) Kind of transformer
b) Number of the specification
c) Manufacturer's name
d) Year of manufacture
e) Manufacturer's serial number

f) Number of phases and frequency
g) Rated power
h) Rated voltages and currents
i) Connection symbol
j) Impedance voltage at rated current
k) Type of cooling
l) Total weight
m) Weight of insulating oil
n) Class of insulation
o) Temperature rise
p) Connection diagram
q) Insulation levels
r) Weight of transportation and untanking
s) Details regarding tapping's

9.0 Technical parameters to be monitored through SCADA through Remote.

- Transformer health : Winding temperature
- Safety parameter breach / transformer door open

PART- 4 L.T. PANEL

1.0 System:

- **Declared voltage** :– 3 Phase,433V (±5%) 50 Hz,
- **Neutral**: – Solidly earthed at substation.
- **Bus bar:** – Aluminum

1.1 General finish:-

Tropical, totally enclosed, metal-clad, weather-proof, vermin and dustproof.

1.2 Construction :

Enclosure:- Dead Front type of enclosure shall be able to provide the degree of Protection IP:4X.

1.3 Circuit Ways:

INCOMER – Amp as per TF rating, ACB EDO type 50KA with metering module
OUTGOING – 4 No 400 A, ACB/MCCB 35 KA with Long Time , Short Time , Instataneous, Ground Fault (**LSIG) protection** and metering module

Preferred Make of the ACB– Schneider Master pack NW/ABB Emax/Siemens 3WL

2.0 GENERAL CHARACTERISTICS OF ACB:

2.1 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

2.2 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.
- Different versions shall be available with rated ultimate short circuit breaking capacity (Icu) from 50kA at 433V 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 de-rating their performances and without jeopardizing 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 433 V AC must be and without the need for maintenance of the contacts and arcing chambers shall 9000 operations up to 2000 A
- These values are intended to be valid only for CAT B circuit-breakers.

2.3 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 de-rating up to 2000 m.s.l. (6600 ft), and with de-rating up to 5000 m.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.

2.4 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 standardizing 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 pre-charged springs fitted with anti-pumping 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.

3.0 RELAYs

Relay (Protection functions)

- The relays must not require auxiliary power supplies since the power is taken from the current transformers.
- The relays should operate only with external signals and not power supplied by internal batteries. The basic version of the relays 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)

4.0 General aspects of MCCB with Thermal Base 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.

4.1 Molded case circuit breakers functional features

- Rated insulation voltage (Ui) for MCCB shall be 800 V AC or more.
- Rated Impulse withstands 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 800 A with trip units settings starting from 1 A
- 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 50-100% of rated ultimate short circuit breaking capacity (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 @ 380/433 V AC.
- Both line up and line down supplying must be possible without decreasing MCCBs performances or functionality

- MCCB shall confirm 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 800A
- A test bottom for the correct functionality checking (moving contacts opening) must be place in front of the breaker.

4.2 Ambient characteristics

- Operating temperature: -25 °C ..+70 °C (ambient temperature)
- Storage temperature: -40 °C .. +70 °C (ambient temperature)
- Reference temperature for setting the thermal element of the thermo magnetic trip unit: +40 °C
- Maximum relative humidity: 98%
- Maximum altitude: 2000 m above sea level, 5000 m above sea level with de-rating Suitability for being used in hot-humid places.

4.3 Construction characteristics

- The range of molded case circuit-breakers must cover a range of rated uninterrupted currents from 10 to 1000 A.
- By means of the double insulation technique, molded case circuit-breakers must guarantee complete separation between the power circuits and the auxiliary circuits.
- Molded 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).
- Molded case circuit-breakers must be suitable for isolation in compliance with the IEC 60947-2 Standard. This indication must be clearly and indelibly marked on the circuit-breaker (in accordance with IEC 60947-2) and in a position where it is visible with the circuit-breaker installed.
- Molded case circuit-breakers with rated uninterrupted current up to 250A shall have a 45 mm high face which makes them suitable for installation on modular panels.
- For the front parts of the circuit-breakers the degree of protection of at least IP20 (excluding the terminals) must be guaranteed.

4.4 Protection trip units

a) Thermo magnetic over current trip units

- Thermo magnetic trip units shall be fitted with protection threshold against overload (whose thermal element must consist of a bi-metal) and with protection threshold against short circuit.
- The protection threshold against overload must be continuously adjustable starting from 0.7 times the rated current of the trip unit and up to its rated value.
- The reference temperature for setting the thermal element of the protection trip unit is 40°C. The temperature performance of the trip unit must be indicated as the temperature varies.

- The protection threshold against short-circuit can be either the fixed or adjustable type with continuity from 5 and up to 10 times the rated current of the trip unit. For current rating upto 250Amps, magnetic threshold be minimum of 10 times of rated current.

b) Magnetic only over current trip units

- The over current trip units with magnetic only threshold shall be suitable for protection against short-circuit.
- The adjustable magnetic only trip units (suitable for motor protection) shall only be available in the three-pole version, whereas those with fixed threshold shall also be available in the four-pole version.
- The adjustable magnetic only trip units must be available for circuit-breakers up to 250 A with an upper magnetic threshold equal to Im =3200

5.0 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.

5.1 Molded case circuit breakers functional features

- Rated insulation voltage (Ui) for MCCB shall be 800 VAC or more.
- Rated Impulse with stand 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).
- According to IEC 60947-2 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 @ 380/433 V AC.
- Supply in the up and down line should be possible without affecting the MCCB’s performance or functionality.
- MCCB shall conform to current limiting type as this will ensure minimum let through energy at the time of opening on fault. The MCCB shall have opening time less than 10msec for current rating upto 630A, and less than 15msec for current rating upto 1600Amps.
- A test button must be placed in front of the breaker to check its functionality.

5.2 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 de-rating
- 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.

5.3 Construction characteristics

- The 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 tripping of 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.

5.4 Protection trip units

- From the 250A size circuit-breakers, the trip unit must be interchangeable, electronic type over current releases
- The electronic type over current 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:
- Function L:adjustable trip threshold I1= (1...10) 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.
- 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.
- 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 rating 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.
- The LT and HT Switchgear used in the Package Substation should be of same make.

6.0 Technical parameters to be monitored from SCADA

- Feeder data : switch ON/OFF
- Energy consumption data
- System power quality (Power factor / THD content)
- Event recording

7.0 FACTORY ACCEPTANCE TESTS (FAT)

All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the bidder and Employer's representatives during manufacture, erection and on completion. The approval of the Employer or passing such inspections or tests will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service. The detailed requirement of operational and pre-FAT tests as well as FAT test (Integrated Test) is given in this Section.

The FAT shall be mutually agreed upon and approved by Employer during detailed engineering.

PART-5 CIVIL WORKS:

All civil work shall M15 grade
The work shall include the following

- Mass plinth foundation for mounting RMU and associate combination of Isolators and Breakers.
- Mass plinth foundation for steel supports for mounting DTs and foundation for DTs suit to the site conditions.
- Foundation at water logging areas shall be elevated and no additional cost will be paid for the same.

PART-6 HT ALUMINIUM XLPE ARMOURED UG CABLE

1.0 SCOPE:

The specification covers the design, manufacture, testing, supply and delivery in proper packed condition of 3 core, 185/300 sqmm, aluminum Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, Armoured, screened Power Cables.

2.0 *STANDARDS*: The Cable shall conform to the following standards.

IS: 7098 (Part-II) (Latest)	Specification for cross-linked polyethylene Insulated PVC Sheathed Cables for working Voltages 11 KV and 33 KV
IS: 8130-1984	Specification for Conductors for insulated electric cables and flexible Cords
IS: 5831-1984	PVC insulation & sheath of electric cables
IS: 3975-1970	Armour for cables (for 3 Core)
IS: 10810-1984	Methods of test for Cables.
IS: 10418-1982	Cable Drums for Electric Cables.
IS : 3961 (Part 2)	Recommended current ratings for cables of PVC insulated and PVC sheathed heavy duty cable
IS : 1885	Electric Cables

The cable, joints, outdoor termination and their accessories and fittings may conform to other Indian and/or equivalent Standards or important publications to improve upon their performance but shall not fall short of the requirement of this specification. The bidder shall abide by such standards in their offers.

3.0 CABLE SPECIFICATIONS:

Voltage grade (KV) of cable required	19/33, 6.35/11
Service Voltage	33 KV ,11 KV
Highest Voltage	36 KV, 12 KV
Earthing System	Delta connected system with earthing
Earthing of Transformer	Solidly earthed
Basic insulation Level For Cable	170 KV for 33 KV Grade 75 KV for 11 KV Grade
Fault Level (Max.)	25 Ka for 1 Sec.
Frequency	50 C/S, 50 C/S

4.0 WEATHER CONDITION:

Monsoon prevails generally from the month of June to October with showers sometimes heavy, acidic, smoky, industrial and foggy.	
Maximum ambient temperature	: 50 degree C.
Minimum ambient temperature	: 4 degree C
Thermal resistance of soil	: 150 degree C-Cm/Watt
Maximum Daily average ambient temp	: 40 degree C
Maximum relatively humidity	: 100.00%
Average rainfall per annum	: 100 cm
Maximum height above the Sea level	: 2000 Meters

5.0 ELECTRICAL CHARACTERISTICS & PERFORMANCE:

1	Description of Cable	
A	19/33 KV Grade	Standard compacted circular Aluminium (H2/H4 Grade) Conductor, shielded with black extruded semi-conducting compound XLPE insulated, core shielded with black extruded semi-conducting compound, black semi-conducting tape and a copper tape, coloured strips having Red, Yellow & Blue for core identification, shielded cores laid up with fillers, binder taped and Black extruded PVC (Type ST-2) inner sheath, single layer of round galvanized steel wire armoured and black extruded PVC
b	6.35/11KV Grade	Same as above but insulation shielding with black semiconducting tape not necessary. Inner sheath to be wrapped not extruded and strip armoured not wire armoured. The design shall fully conform to IS:7098 (Part-II)
2	Voltage Grade	19/33KV (For 33 KV System) 6.36/11KV (For 11 KV System)
3	Size Of Cable	300 sqmm (For 33 KV System) 185 sqmm (For 11 KV System)
4	Service of Voltage	33 KV, 11 KV
5	Maximum Conductor temp	90 degree C at max continuous current. 33KV System, 11KV system
6	Short circuit. Current	1) 28.2 KA for 1Sec for 33 KV 300 Sqmm 2) 17.39 KA for 1Sec for 11KV 185 Sqmm
7	Maximum Permissible short circuit Temperature	250 degree C for one second
8	Conductor Material	Material to IS: 8130, H2/H4 Grade Aluminium Conductor, stranded compacted circular
9	Conductor screen	Extruded, cross linked, semi-conducting compound of 1.0 mm. thickness for 33 KV and 0.5 mm. thickness for 11 KV
10	Insulation	XLPE thickness, 8.8 (Minimum) for 33 KV and 3.6 mm. (Nominal) for 11 KV
11	Insulation Screening For 33 KV, For 11 KV	Combination of black extruded semi-conducting compound &Semiconducting tape as the non-metallic part and annealed copper 0.06 mm (minimum) thick tape lapping as metallic part. It is same but semi-conducting tape is not required
12	Inner Sheathing	Black extruded PVC Type ST-2 compound for 33 KV and wrapped PVC tape for 11 KV as per IS 7098: Part 2
13	Armouring	Single layer of round galvanized steel wires/strips as per IS 7098: Part 2 both for 33 KV and 11 KV
14	Overall Sheathing	Coloured PVC Type ST-2 compound to IS:5831, extruded for both 33 KV and 11 KV thickness shall be as per relevant IS code
15	End Sealing	Heat Shrinkable Caps
16	Impulse Tests	170 KV for 33 KV , 75 KV for 11 KV
17	H.V. Tests between Conductors & Screen/Armour	48 KV (rms) for 33 KV for 5 minutes and 24 KV for 11KV as per IS Standard
18	Maximum D.C Resistance per KM	As per relevant IS Standard
The above parameters are applicable for 3-Core		

6.0 CABLE CONSTRUCTION :

6.1 XLPE Underground Cable: XLPE Underground Cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials for XLPE main insulation and XLPE semi-conducting Insulation & XLPE screen. The inner and outer semiconducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded during the Triple Extrusion Process of manufacturing and main insulation of the Cable is to be extruded unfilled. The XLPE Cable in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armour wires which shall be ensured by guarding against corrosion.

6.2 CONDUCTOR SCREENING: A semi-conducting cross-linked polyethylene (XLPE) screening shall be extruded over the conductor to act as an electrical shield which together with the elimination of the so called “Strand Effect” prevents to a great extent air ionization on the surface of the conductor.

6.3 INSULATION: The main insulation of the Cable shall be extruded unfilled, chemically cross-linked polyethylene (XLPE) inert gas cured satisfying the requirement of ISS: 7098(Part-II).

6.4 INSULATING SCREEN: The screen shall be made up as per relevant IS code. The metal screen eliminates tangential stress of rotating electrostatic field surrounding the conductor and uniform electrical stress in the insulation. The semi-conducting polyethylene (XLPE) screen shall be extruded over the main polyethylene insulating wall to prevent partial discharge at the surface of the insulation. The copper tape shall be wrapped over the semi conducting tape or extrusion as mentioned earlier for 3 core cables. The metal screen so formed around the cores shall be in contact with one another as the cores are laid up at triangular configuration. For single core cable, Aluminium wire armouring shall constitute the metallic part of insulation screen. Conductor screening, insulation and insulation screening shall be extruded in triple extrusion processes so as to obtain continuously smooth interfaces. The mechanical and chemical properties of the materials for semi conducting screens are much more important than their electrical properties, but for obtaining the high overall degree of electrical properties of an E.H.V. cable, the inner and outer semi conducting screens and the main polyethylene insulation between the screens shall be simultaneously extruded during the manufacturing process known as “triple extrusion”.

The advantages are:-

- The partial discharge level at the surface of the insulation is brought to a minimum.
- There will be no displacement of the semi conducting screen and insulation during expansion and contraction due to load cycles and bending.
- The semi conducting screens are easily removable during jointing and termination operations.

6.5 LAYING UP:

The phase identification of the cores shall be either by colour or numerals as per IS Specifications for 3 core cables only.

Core Colour Numeral

- Red 1
- Yellow 2
- Blue 3

The screened cores shall be laid up with interstices filled with PVC fillers and taped with a binder tape as to obtain a reasonably circular cable.

6.6 INNER SHEATH: The cable core shall be supplied with bedding of PVC (inner sheath) in the form of extruded PVC sheath for 33KV cables. Wrapped PVC tapes shall be used for 11 KV thickness as per relevant IS code.

6.7 ARMOUR : The cable shall be wire armoured/Steel strip in case of 33KV and wire/Strip armoured in case of 11 KV, 3 Core cables to ensure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. The Steel Wires/Aluminium Wires/Steel Strips of required size in requisite number shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cross sectional area for flow of maximum fault current within limits of specified temperature rise and duration of fault. The direction of the lay of the armour shall be opposite to that of the cable cores.

6.8 OUTER SHEATH:

A reliable serving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. The cable shall therefore be finished with an extruded PVC over sheath of thickness as per relevant IS code. The quality of PVC over sheath (Jacket) shall be ensured for service reliability against moisture intrusion and shall conform to type ST-2 of IS: 5831. The colour of the outer sheath shall be as follows: For 33 KV Cable: Red &For 11 KV Cable: Black. The sheaths shall be protected against white ants, vermin and termites by suitable, reliable and durable measures. The bidder shall suggest suitable materials for use, in the event of damage to the over sheath to prevent passage of moisture along the cable.

6.9 CABLE IDENTIFICATION: The following shall be embossed on the outer sheath for the identification.

- Manufacturer's Name or Trade Mark.
- Voltage Grade.
- Nominal section & Material of conductor and number of cores.
- Year of manufacture.
- Inscription for length of cables at 1.0 meter interval.
- Name of the purchaser:
- Marking "Electric" shall be embossed throughout the length of the Cable at 10 meters spacing.
- Type of insulation i.e. XLPE.

6.10 SEALING OF CABLE ENDS:

The cable ends in the wooden drums for delivery shall be sealed with heat shrinkable caps.

7.0 WOODEN DRUMS:

The Cable shall be packed in non-returnable wooden drums. Drums shall be proofed against attack by white ants or termite conforming to IS: 10418. The Drums may also be marked with ISI Certificate Mark, if applicable. Safe Pulling Force: 30 N/mm2 (for Conductor)

7.1 The following information shall be marked on each drum.

- Drum identification No.
- Manufacturer's Name, Trade Name/Trade Mark, if any.
- Nominal sectional area of the conductor of the cable.
- No. of Cores.
- Type of Cable and Voltage Grade with Cable Code.
- Length of the Cable in Cable Drum.
- Direction of rotation of Drum (by means of an arrow)
- Approximate Weight: Tare: Gross
- Year and Country of Manufacture.
- Purchase Order No.
- Date of Delivery.
- Name of the Purchaser:

8.0 Tests to be performed as per IS: 7098 (Part-II)

8.1 Type Test: All the tests mentioned below are to be made as per details given in IS:10810

a) Tests on conductor

- Tensile Test (for aluminium)
- Wrapping Test (for aluminium)
- Resistance Test.

b) Tests for armouring Wires strips.

Test for thickness of insulation and sheath

i. Physical test for insulation.

- Tensile strength and elongation at break.
- Ageing in air oven.
- Hot test.
- Shrinkage test
- Water absorption (Gravimetric)

ii. Physical tests for outer sheath

- Tensile strength and elongation at break.
- Ageing in air oven.
- Shrinkage test.
- Hot deformation.
- Heat shock.
- Loss of mass in air oven.

- Thermal stability.

iii. Partial discharge test.
iv. Bending test.
v. Dielectric power factor test.

- As a function voltage.
- As a function of temperature.
- Insulation resistance (Volume resistivity) Test.

vi. Heating cycle test.
vii. Impulse with stand test.
viii. High voltage test.
ix. Flammability test.

8.2 The following tests on screened cable shall be performed successively on the same test sample of completed cable, not less than 10m. in length between the test accessories.

8.2.1 P.D. (Partial Discharge) Test.
8.2.2 Bending Test followed by P.D. Test.
8.2.3 Dielectric power factor as a function of voltage.
8.2.4 Dielectric power factor as a function of temperature.
8.2.5 Heating cycle test followed by dielectric power factor as a function of voltage and P.D tests.
8.2.6 Impulse withstand test and
8.2.7 High voltage test.

8.3 Acceptance Test:

The following shall constitute Acceptance Tests:

8.3.1 Tensile test (for aluminium)
8.3.2 Wrapping test (for aluminium)
8.3.3 Conductor resistance test.
8.3.4 Test for thickness of insulation and sheath.
8.3.5 Hot set test for insulation.
8.3.6 Tensile strength and elongation at break test for insulation and outer sheath.
8.3.7 P.D test (for screened cables) only on full drum length.
8.3.8 High Voltage test,
8.3.9 Insulation resistance (VOLUME RESISTIVITY) TEST

8.4 ROUTINE TESTS:

The routine test shall be carried out on all cables manufactured in accordance with this specification. The following routine tests shall be made on cable length as specified in the IS.

8.41 Conductor resistance test.
8.42 Partial discharge test on full drum length.
8.43 High voltage test

8.5 TEST WITNESS: All Tests shall be performed in presence of Purchaser's representative if so desired by the Purchaser.

9.0 TEST CERTIFICATE:

- Certified copies of all routine tests carried out at Works shall be furnished in Six (6) copies for approval of the purchaser.
- The cables shall be dispatched from Works only after receipt of Purchaser's written approval of shop test reports.
- Type Test Certificates of the Cable offered shall be furnished. Otherwise the cable shall have to be type tested on similar rating.

10.0 DESCRIPTIVE LITERATURES, TEST RESULTS ETC. :

The following details for the cable shall be submitted with bid.

10.1 Manufacturer's Catalogue giving cable construction details and characteristics.
10.2 Manufacturing process in detail for cables highlighting the steps to control.

- Contamination.
- Formation of water trees.
- Effects of byproducts of cross-linking.
- Stress control etc.

10.3 Cross section drawing of the cable.
10.4 Cable current ratings for different types of installation inclusive of all de rating factors due to ambient temperature, grouping etc.
10.5 Over-Load characteristics of the cable without endangering the normal life and electrical quality of the insulation.
10.6 Complete technical data of the cables.
10.7 List of Customers to whom the Cable of similar rating have been supplied.

11.0 FACTORY ACCEPTANCE TESTS (FAT)

All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the bidder and Employer's representatives during manufacture, erection and on completion. The approval of the Employer or passing such inspections or tests will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service. The detailed requirement of operational and pre-FAT tests as well as FAT test (Integrated Test) is given in this Section. The FAT shall be mutually agreed upon and approved by Employer during detailed engineering.

PART-7 LT UPTO (1100 V) XLPE INSULATED UG CABLES

1.0 SCOPE:

The scope of this specification covers the design, manufacture inspection and testing the finished ISI marked LT (1100 volts, 2/4C x 4 Sq.mm to 185 Sqmm power cables stranded Aluminium, XLPE Insulation, inner sheath must be extruded type of PVC ST2, aluminium flat strip armoured, Overall PVC Sheathed cable conforming to IS 7098-I

2.0 APPLICABLE STANDARDS:

2.1 The latest version of the following Standards shall be applicable:

2.1.1 IS 7098 (Part 1)-Cross-linked Polyethylene insulation for Cables.
2.1.2 IS 8130-Conductors for insulated electrical cables and flexible cords.
2.1.3 IS 10810(series)-Methods of tests for cables.
2.1.4 IS 10418-Drums for electric cables.
2.1.5 IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables.
2.1.6 IS 5831-Specification for PVC insulation sheath for electric cables.
2.1.7 IS 10462-Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables.

2.2 The cables manufactured to any other International Standards like BIS, IEC or equivalent standards not less stringent than Indian Standards are also acceptable. In such cases the Bidders shall enclose a copy of the equivalent international standard, in English language, along with the bid.

3.0 RATED VOLTAGE:

3.1 The rated voltage of the cable shall be 1100 Volts AC with the highest system voltage of 1200 Volts between phases of the effectively earthed three-phase transmission system.

3.2 The cables shall be capable of operating continuously under the system frequency variation of ± 3 Hz, voltage variation of ± 10% and a combined frequency-voltage variation of ±10%.

4.0 CONSTRUCTION:

4.1 Conductor:-The cable conductor shall be made from stranded aluminum to form compact sector shaped conductor having resistance within the limits specified in IS: 8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay. Stranded Class 2 – as per the IS:8130 / IEC 60228/ BS 6360 standards.

4.2 Insulation:-The insulation shall be cross linked polyethylene applied by extrusion and shall be steam (wet) cured as pre IS:7098(1)1988 and curing in hot water tank/bath is not accepted.:

Sl. No.	**Properties**	**Requirements**
1.	Tensile Strength	12.5N/mm², Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven:	
	a) Treatment: Temperature:	135±3°C
	Duration:	7 days
	b) Tensile Strength variation:	±25 percent, Max
	c) Elongation variation:	±25 percent, Max
4.	Hot set:	
	a) Treatment: Temperature:	200±3°C
	Time under load	15 min

		Mechanical stress	20N/cm²
	b)	Elongation under load	175 percent, Max
	c)	Permanent elongation (set) after cooling	15 percent, Max
5.	Shrinkage:		
	a)	Treatment: Temperature	130±3°C
		Duration	1 hour
	b) Shrinkage		4 percent, Max
6.	Water absorption (Gravimetric):		
	a)	Treatment: Temperature:	85±2°C
		Duration	14 days
	b)	Water absorbed	1 mg/cm², Max
7.	Volume Resistivity		
	a)	at 27°C	$1x10^{14}$ ohm-cm, Min
	b)	at 70°C	$1x10^{13}$ ohm-cm, Min
8	Thermal Resistivity		350 degrees C cm/W
9	Power factor at maximum conductor Temperature		0.008
10	Dielectric strength		22 kV/mm

4.3 The XLPE insulation should be suitable for specified 1.1 KV system voltage. The manufacturing process shall ensure that insulations shall be free from voids.

4.4 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.5 The insulation of the cable shall be high stranded quality, specified in IS: 7098 (Part-II/1985).Withstand continuous conductor temperature of 90 deg C, which means higher continuous rated current carrying capacity.

4.6 The cables can operate even at conductor temperature of 130 deg C continuously and 250 deg C during a Short Circuit condition

4.7 SHEATH: The sheath shall be suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness, consistent quality and free from all defects. The PVC sheath shall be extruded as per IS:7098 (Part-I/1988). IEC:60502 Part– I, BS:6622, Low smoke zero halogen (LSOH) to BS:783

4.8 ARMOUR:-Armoring shall be applied over the inner sheath with single galvanized steel complying with the requirements of IS:3975/1979. The dimensions of the galvanized strip shall be as specified in table 4 of the IS:7098/Part-I/1988. The armour wire shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any

wire shall be at least 300mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS:7098 Part 1, IS: 3975.

4.9 OUTER SHEATH:- Extruded PVC ST2, outer sheath as per IS:5831/1984, IS:7098 Part 1,IEC:60502 Part – 1, BS:6622, LSOH to BS:78 35. Shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc, shall not have adverse effects on the PVC sheathing material used.

4.10 The cables should be suitable for use in solidly earthed system.

4.11 The power cables shall be manufactured to the highest quality, best workmanship with Scientific material management and quality control. The bidder shall furnish the quality plan, giving in detail the quality control procedure / management system.

4.12 The cable shall be suitable for laying in covered trenches or buried underground to meet the outdoor application purposes.

4.13 The short circuit current of the LT cable to be as specified below

Sq.mm of LT Cable	Short Circuit Current(KA)
4	0.376
6	0.564
10	0.940
16	1.504
25	2.350
35	3.290
50	4.790
70	6.680
95	9.030
120	11.400
150	14.200
185	17.500
300	28.200

5.0 SYSTEM DETAILS:

General Technical particulars

Nominal system voltage (rms) (U)	0.44KV
Highest system voltage (rms) (U_m)	1.1 KV
Number of Phase	3P+N
Frequency	50Hz
Variation in Frequency	+/- 3%
Type of Earthing	Solidly Earthed
Total relay & circuit breaker Operating time	15 – 20 cycles

6.0 CLIMATIC CONDITIONS:

Maximum ambient air temperature (in shade)	45^0 C
Maximum ambient air temperature (under sun)	50^0 C
Maximum daily average ambient air temperature	35^0 C
Maximum yearly average ambient air temperature	30^0 C
Maximum humidity	100%
Altitude above M.S.L.	Upto 1000M
Average No. of thunder storm days per annum	50
Average No. of dust storm days per annum	Occasional
Average No. of rainy days / annum	90
Average Annual Rain fall	925mm
Normal tropical monsoon period	4 months
Maximum wind pressure	150 kg/Sq.M

7.0 DESIGN CRITERIA:

7.1 The cables that are covered in these specifications are intended for use outdoor, under the climatic conditions and installation conditions described in the technical specification.

7.2 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only, in the offer made by the bidder, giving technical reasons, and justifying the need to incorporate these features.

7.3 For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.

7.4 The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.

7.5 The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

7.6 The cables shall have the mechanical strength required, during handling and laying.

7.7 The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.

7.8 The cables shall be designed to have a minimum useful life span of Thirty-five years.

8.0 MANUFACTURE PROCESS:

Cross-linking of the insulation materials (pre compounded polyethylene) shall be conforming to IS: 7098 (Part–I) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection.

9.0 CONDUCTOR MATERIALS:

The conductor shall be of stranded construction. The material for conductor shall consist of the plain aluminum of H2 or H4 grade as per clause – 3 of IS 8130/ 1984.The minimum number of wires shall be 53 for circular compacted 185 sq. mm aluminum conductor as per table – 2 of IS 8130/ 1984.

10.0 CORE IDENTIFICATION:

The core identification for 31/2/3.5/4 core cables shall be provided, by suitable means, like, by application of individual colour or colored stripes, or by numerals or by printing on the cores as per clause 13 of IS: 7098 - Part 1

For identification of different coloring of XLPE Insulation, or by using colored strips, red, yellow, blue and black colors respectively shall be used to identify the phase conductors and neutral.

11.0 LAYING UP OF CORES:

The cores shall be laid together with a suitable right hand lay. The interstices at the center shall be filled with a non- hygroscopic material.

12.0 INNER SHEATH (COMMON COVERING):

12.1 The laid up cores shall be provided with inner sheath applied either by extrusion. It shall be ensured that the shape is as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

12.2 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as a part of inner sheath.

13.0 ARMOURING:

Armouring shall be single strip steel wire applied over the inner sheath as closely as practicable. The direction of the lay of the armour shall be left hand.

The armour shall consist of galvanized strip steel. .The dimensions of the galvanized steel wires shall be 4 X 0.8 mm (Nominal)

The joints in the armour strip shall be made by brazing or welding and the surface irregularities shall be removed. A joint in the wire shall be at least 300-mm from the nearest joint in any other wire in the complete cable.

14.0 OUTER SHEATH:

The outer sheath shall be applied by extrusion. It shall be applied over the armouring shall consist of poly-vinyl chloride (PVC) compound, conforming to the requirements of type ST- 2 of IS 5831. Suitable additives shall be added to give anti termite protection.

15.0 ACCEPTANCE TEST:

The sampling plan for acceptance test shall be as per IS 7098 part –I,.

The following shall constitute the acceptance test.

a) Tensile test for aluminum.
b) Wrapping test for aluminum.
c) Conductor resistance test.

d) Test for thickness of insulation.
e) Test for thickness of inner and outer sheath.
f) Hot-set test for insulation.
g) Tensile strength and elongation at break test for insulation and outer sheath.
h) High voltage test.
i) Insulation resistance (volume resistivity) test.

16.0 ROUTINE TEST:

The following shall constitute routine tests:

a) Conductor resistance test.
b) High voltage test.

17.0 FACTORY ACCEPTANCE TESTS (FAT)

All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the bidder and Employer's representatives during manufacture, erection and on completion. The approval of the Employer or passing such inspections or tests will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service. The detailed requirement of operational and pre-FAT tests as well as FAT test (Integrated Test) is given in this Section. The FAT shall be mutually agreed upon and approved by Employer during detailed engineering.

PART-8 FEEDER PILLARS:

Sub feeder pillar panels shall be suitable for AC 440 V , 50 HZ supply, fabricated with 14 gauge galvanised steel sheet duly pre-treated and pure polyester thick powder coated 80 micron thickness using Siemens gray colour shade no. RAL-7032 / any other colour if required by client. The feeder pillar shall be double door in cubical formation, compartmentalized in form with front open able doors. The door shall be provided with concealed hinges and with brazing wherever required to avoid deformation and shall be earthed. The entire door shall have heavy duty door locks, and shall be sealed with neoprene gaskets. The feeder pillar shall be IP 55, outdoor type weather, dust and vermin proof having canopy type tapered roof self-standing type as per approved GA diagram. The feeder pillar shall have lifting hooks and base channel of size 50 x 40 x 6 mm. The feeder pillar shall be complete with bus bars, wiring , cabling of proper ratings (not less than 1.5 times the rating of respective switchgears, control gear etc.) for inter connection between switch gear , control gear, metering , safety relays, indicators etc. as per the approved single line diagram. The feeder pillar shall have proper arrangement for termination of all incoming and out goings cables. All the bus bars shall be supported on epoxy supports and shall be insulated with colour coded heat shrinkable sleeves. **Feeder pillar shall be as per the space available at site**. It shall have earthing bolts at both sides inter connected with 50x5 mm Al earthing bus along the width of feeder pillar. **Note:**-The general arrangement drawing for panel should be approved by consultant / engineer in charge before fabrication. The feeder pillar shall have space and proper arrangements for installation of incoming and outgoing MCCBs with R,Y,B LED type indicating lamps. HRC fuse bases, MCBs etc. complete with interconnection provisions with providing wiring and bus bars with required hardware, sleeves, ferrules, supporters, locks etc. Panel shall have proper space and arrangements for termination of incomer loop in loop out cables, outgoing service cables, with

proper offsets in bus bars for cable terminations. The feeder pillar should have anti-theft tamper proof feature to automatically send SMS alert if door opening is attempted by unauthorised person.

PART-9 Street Light

The existing street lighting system replacing with wall mounted street lighting system. The average LUX of "30" has to be maintained on the service road and the wall mount light with carriage accessory cable of required LED Wattage has to be placed in such a way that the average 30 LUX on the road should be maintained uniformly.

PART-10 Earthing

1.0 SCOPE:

This specification covers design, manufacture, inspection, testing before dispatch, supply and delivery at consignees headquarter of Chemical type and Galvanised M.S Rod type earthing sets with clamps and G.I. wire/strip. The earthing sets shall be used to protect the 33 KV, 11 KV, 1.1 KV lines, Substations and distribution feeder pillar from faulty currents.

2.0 CLIMATIC CONDITIONS:

- Peak ambient temperature 50 Degree C
- Maximum average ambient temperature 40 Degree C
- Maximum temperature attainable 60 Degree C
- Maximum relative humidity 100 %
- Minimum relative humidity 50 %
- Average number of thunder storm days per annum 60
- Average number of rainy days per annum 100
- Average annual rainfall 10-100 cm
- Maximum wind pressure 100 Kg/sq.m
- Altitudes not exceeding 1000 mtrs.

3.0 STANDARDS:

The relevant IS code to which this material shall conform is indicated as below:-

For fabricated material

(i) Raw material test (Manufacturer's Raw material test certificate as per IS: 2062- Grade 'A')
(ii) Galvanisation test as per relevant IS:2633.
(iii) Checking/verification of Dimension etc. as per approved drawing.
(iv) Sampling for workmanship and dimension checking 3% of each lot and as per IS-4711-1976.

For Bolt & Nuts:

(i) Sampling as per IS:2614 (1969)
(ii) Dimensions as per IS:6639(1972)/12427 (1988) for bolts and IS:1363 Part-III (1984) for nuts.

(iii) Galvanisation (sampling) as per IS:1367 part-12 1983, mechanical properties and chemical composition (as per IS:1367 part-III-1991/ IS:12427 (1988) for bolts and IS:1367 Part-IV 1980/IS12427-1988 for nuts.

For Spring washers:

(i) Sampling as per IS:6821 (1973)
(ii) Dimension and testing IS:3063 (1972) and permanent set test – DIN-257 part 264.2.2 and 4.2.3
(iii) Electroplating IS:1573 (1986)
(iv) Chemical composition IS:4072 (1975)

For Galvanised steel wire:

(i) As per IS: 280(latest addition)
(ii) Testing as per IS:7887 Grade-III

4.0 INSPECTION, TESTING & CHECKING:

All the tests and inspection shall be made at the works of manufacturer unless otherwise specially agreed upon by the bidder and purchaser at the time of purchase. The bidder shall afford the inspecting officer(s) representing the purchaser all reasonable facilities without charges, to satisfy him that the material is being furnished in accordance with this specification. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is a dispute regarding the quality of supply. The inspection may be carried out by the purchaser at any stage of manufacture/ before dispatch as per relevant standard. Inspection and acceptance of any material by the purchaser, shall not relieve the bidder of his obligation of furnishing material in accordance with the specification and shall not prevent subsequent rejection if the material is found to be defective. The bidder shall keep the purchaser informed in advance, about manufacturing programme so that arrangements can be made for inspection. The bidder shall give 15 days advance intimation to enable the purchaser to depute his representative for witnessing the acceptance and routine tests. The inspection charges would be to the purchaser's account.

TEST BEFORE DESPATCH:- The Chemical/Galvanised M.S. Rod type earthing sets shall be subject to the following tests as per IS at manufacturer's works before dispatch.

ROUTINE/ACCEPTANCE TEST AS PER RELEVANT STANDARD:

For fabricated material

I) Raw material test (Manufacturer Raw material certificate as per ISS: 2062 Grade A).
II) Galvanization test as per relevant IS:1367(Pt. 13th)1983.
III) Checking of Dimensions etc. as per approved drawing.
IV) Sampling of workmanship and dimension checking 3% of each lot and as per IS: 4711-1976.

For Bolt & Nuts

i) Sampling as per IS:2614 (1969)
ii) Dimensions
iii) Galvanization

For spring washers:

I) Sampling
II) Dimensions
III) Galvanization
IV) Chemical composition Galvanized steel wire as per IS:12776/1989 latest addition.

In case bidder use the steel sections manufactured by prime producers then the inspecting officer shall verify and record in the inspection report regarding stamping and mark of prime producers. The purchaser reserves the right to conduct all tests on M.S. Rod type earthing sets. (Name of the equipment/material) after arrival at site and the contractor shall guarantee test certificate figures under actual service conditions.

5.0 MARKING:

Each bundle of earthing sets shall be legibly marked with the physical condition, weight, date of manufacture, trade mark or the name of manufacturer.

6.0 PACKING AND FORWARDING:

The Galvanized M.S Rod type earthing sets shall be supplied in bundles (containing all items) and shall be suitably bound and fastened compactly and shall have a maximum weight of 400 Kgs. The bundles will be suitably protected by wrapping round by hessian cloth/polythene cover to avoid damage in transit and corrosion.

7.0 DETAILS OF APPLICABLE STANDARDS / SPECIFICATION/ MANUALS:

The material shall comply with the relevant provisions made in the following Indian Standards Specification (now BIS) with latest amendments.

1. IS:2062/ 1999 (Latest amended): Hot rolled low medium and high tensile structural steel
2. IS: 2633/1986 : Methods for testing uniformity for coating of zinc coated articles
3. IS:4711/1976 : Methods for sampling of steel pipes, tubes and fittings
4. IS:1367/1983 : Technical supply conditions for threaded steel fasteners
5. IS:1363/1984 : Hexagon head bolts screws and nuts of products grade-C
6. IS:6639/1972 : Specification for hexagon bolts for Steel Structure
7. IS:12427/1988 : Fasteners, headed steel fasteners, hexagon head bolts
8. IS:6821/1973 : Methods for sampling non threaded Fasteners
9. IS:3063/1972: Fasteners single coil rectangular section spring lock washers
10. IS:1573/1986: Specification for Electroplated coatings of zinc on iron and steel
11. IS:4072/1975: Specification for steel washers
12. IS:280: Mild steel wire for general engineering Purpose
13. IS:7887/1992: Mild steel wire rods for general engineering Purpose

All materials shall comply in all respect with the requirement of latest addition of relevant Indian Standard Specification except as modified in this Specification. Where the relevant ISS is not available, the material / sections should comply with the latest BSS.

DISMANTLING OF 33KV, 11 KV, LT, SERVICE OVERHEAD LINES INCLUDING DTs, POLES, etc.

1.0 SCOPE:

This part of the specification covers dismantling of the overhead lines including transportation of the materials to USCL/AVVNL stores. The work comprises of dismantling the existing HT/LT overhead transmission lines, DTs, pole and overhead service mains of the consumers completely after commissioning of the UG cable distribution system. The successful bidder has to dismantle the HT & LT over head lines, Distributing transformer centres of varying capacities, ACSR conductors, of varying sizes like squirrel, weasel or rabbit the hardware associated with it and the insulators, etc. The supports are generally of metallic poles like SM Rails, I-section beams, etc., of varying lengths from 9.0 mtr. to 15.0 mtr long and are to be released from the ground and the earth work back filled. The conductor spans vary from 10 mtr. to 60 mtrs. The work also includes transporting of all the released materials inclusive of scrap to the AVVNL stores.

2.0 JOINT INVENTORY:

The contractor and AVVNL field staff should after a joint inspection, draw up a detailed inventory of the over head distribution system to be dismantled giving numbers of make and capacity wise transformers, and numbers of type of poles to be dismantled, insulators, conductors, cross arms, etc., including their condition and over head service mains of the consumers. The Joint inventory of the proposed to be dismantled materials/equipment will be prepared and handed over to the contractor. The contractor to carefully and safely dismantle the materials as per the approved list and transport them to the designated AVVNL stores. The contractor should only take up the work after joint inventory.

PERFORMANCE INDICATOR

Summary:

Key Performance Indicators (KPIs) for the electrical system in Udaipur Rajasthan. KPIs include the following service quality, reliability, security, health and financial indicators.

- System Average Interruption Frequency Index (SAIFI)
- System Average Interruption Duration Index (SAIDI)
- Underground Lines Maintenance Cost Index (ULMCI)
- Energy loss Index (ELI)
- Power factor (PF)

Key Performance Indicators,

- System Average Interruption Frequency Index (**SAIFI**), which measures the yearly average number of interruptions experienced by each customer.
- System Average Interruption Duration Index (**SAIDI**), which measures the yearly average interruptions duration per customer.
- Energy losses Index (ELI), which is measured monthly

- Power factor **(PF)** which is measured every day.

Calculation

1. **System Average Interruption Frequency Index (SAIFI)**
   SAIFI = Number of Interruptions during One Year/ Number of Customers

2. **System Average Interruption Duration Index (SAIDI)**
   SAID = ∑Duration of Interruption (min.)/ Number of Customers

3. **Energy Losses Index (ELI):Energy loss should not more than 5%**
   ELI=Energy Supplied to consumer (MWh)/Energy received by Consumer (MWh)

4. **Power factor (PF) : Power factor should not be less than .95 power factor**

BENCH MARK OF KPI

S.L	KPI	BENCH MARK
1	System Average Interruption Frequency Index (SAIFI)	0.03%
2	System Average Interruption Duration Index (SAIDI)	0.05%
3	Energy Losses Index (ELI)	5%
4	Power factor (PF)	0.95

TIME SCHEDULE

SL. No	DESCRIPTION	TIME (MONTH)
1	Package Substation installation	6
2	Feeder Fillar	6
3	HT, LT & Service Cable installation	12
4	Connection & termination of HT & LT cable	4
5	Connection & termination of service cable	6
6	Connection & Termination at feeder	1

GUARANTEE:

The Guarantee period for all equipment supplied against the specification mentioned in this document shall be for a period of 60 months from the date of commissioning.

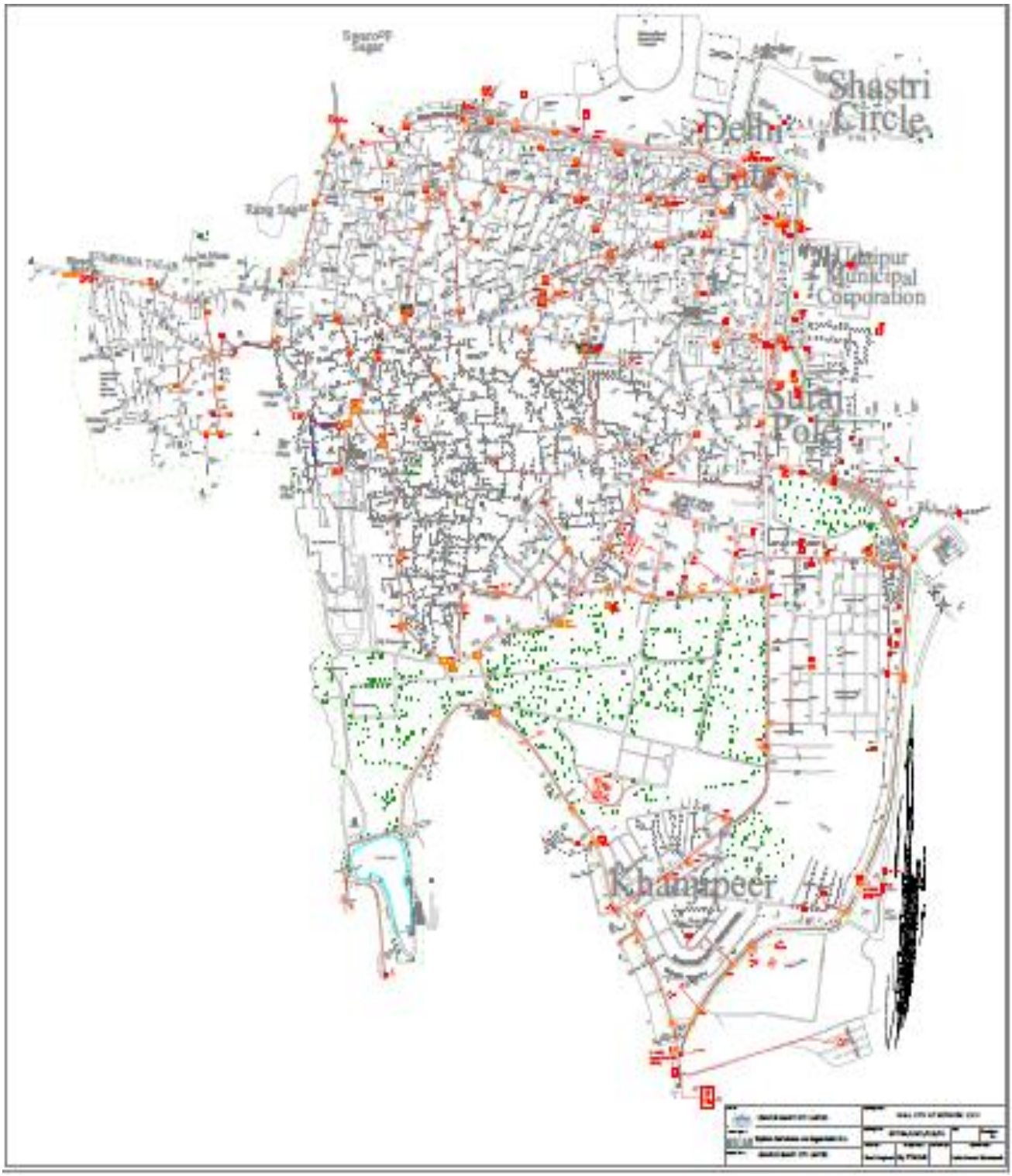


Fig.-2 RMU, CSS and HT Network dwg.

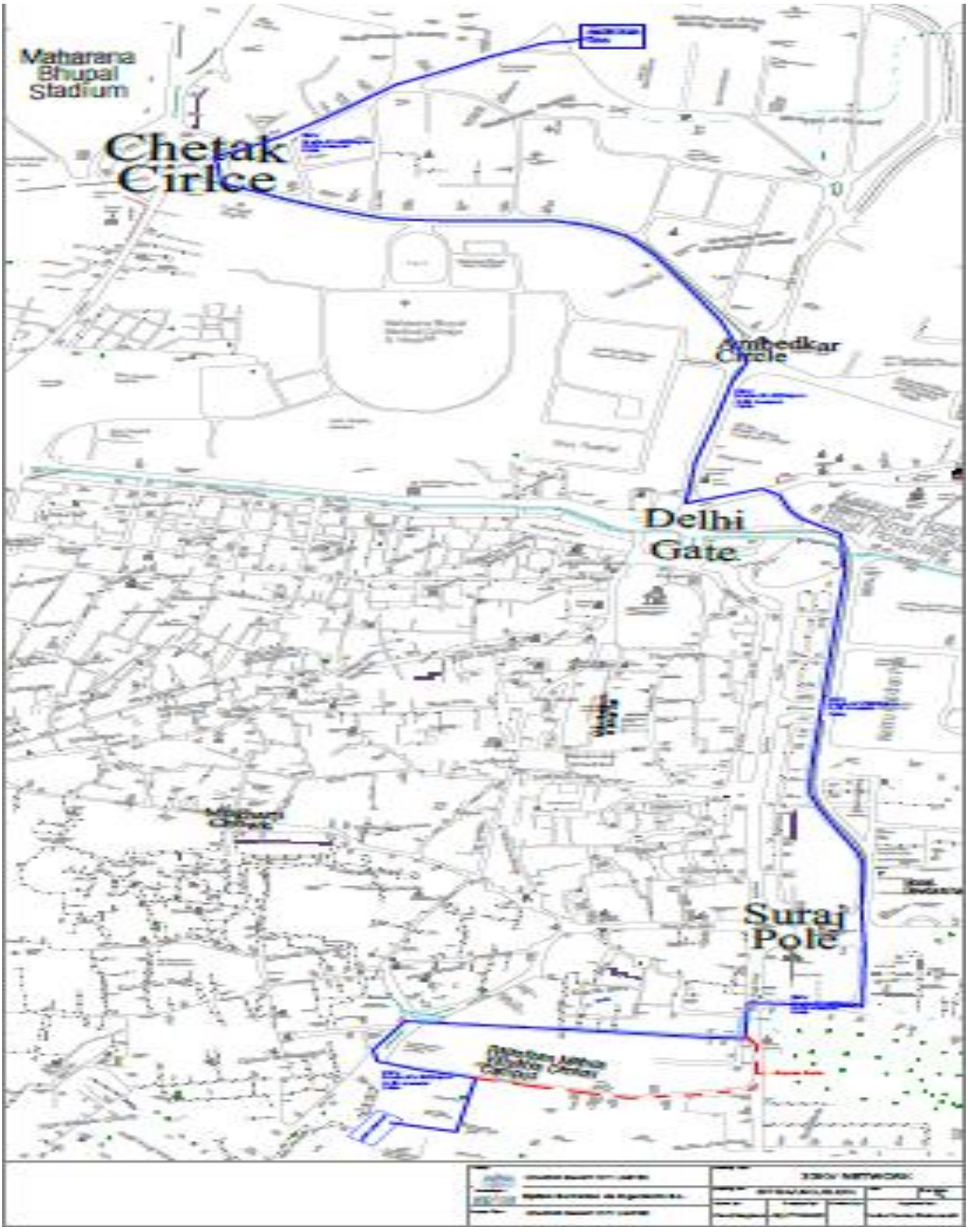


Fig.-3 HT 33 KV Line

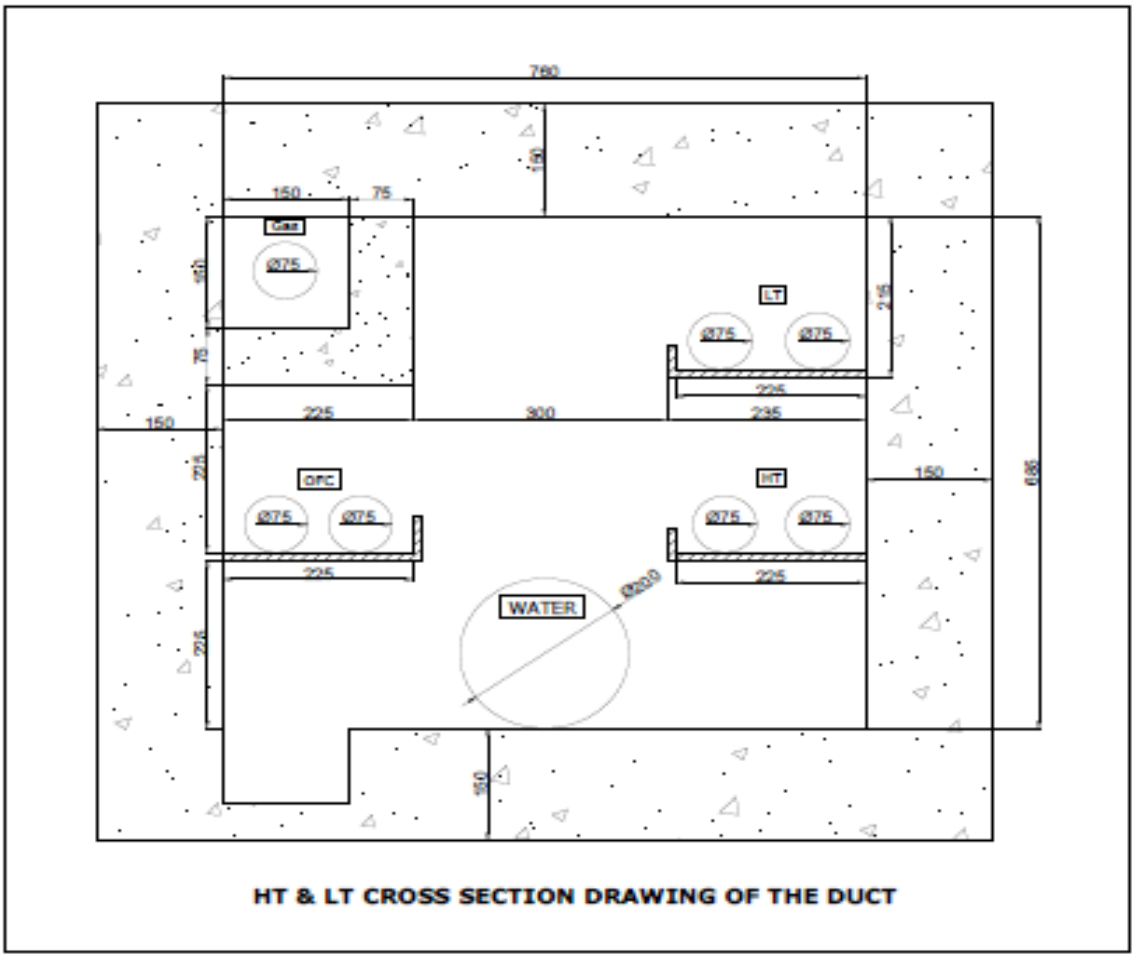


Fig. 4 Cross section duct

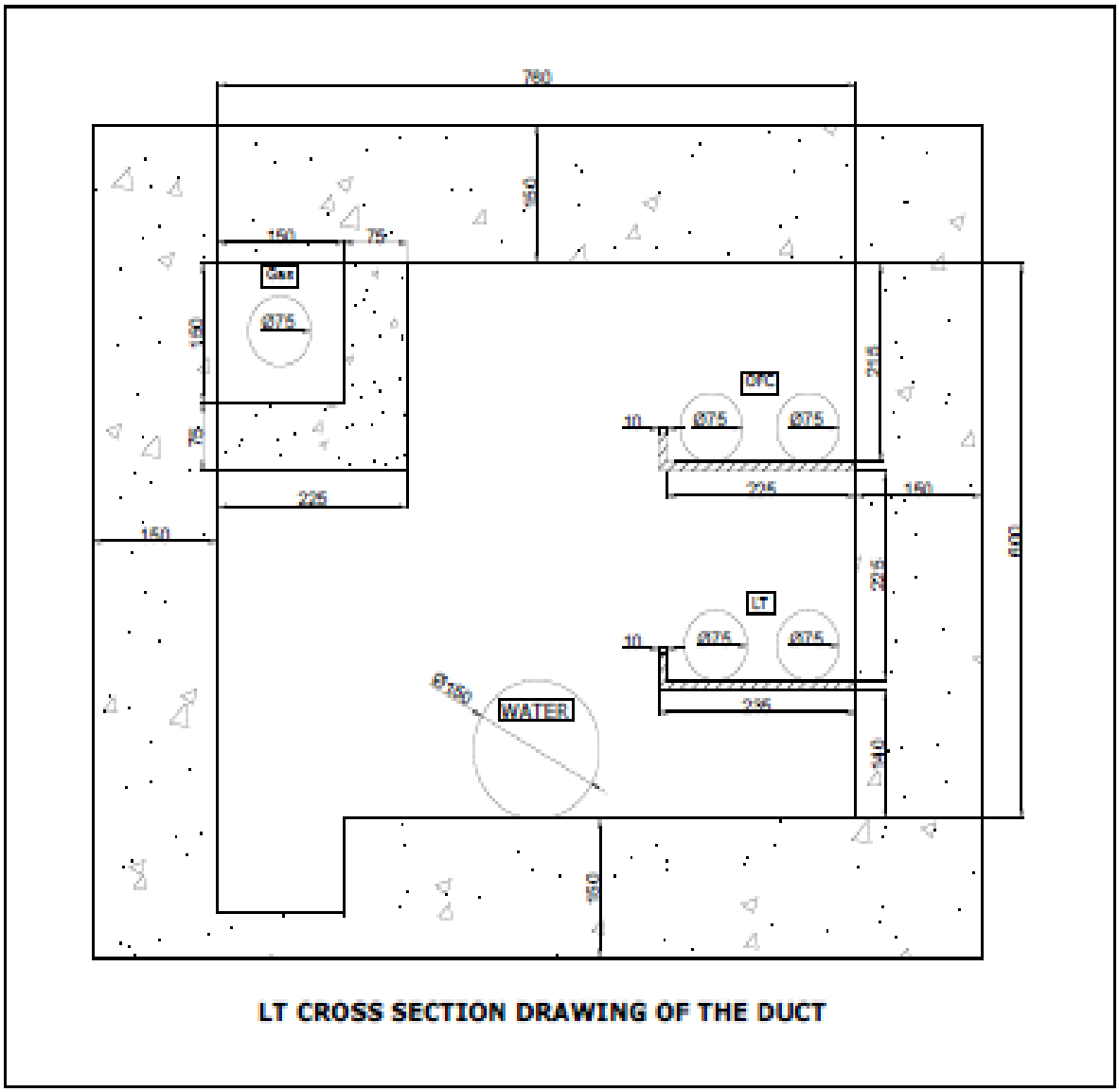


Fig.-5. LT duct

SCADA for Electrical Works

This is detailed in a separate section VI C of this document.

Section V-D (UTILITY DUCT)

SCOPE OF WORK and TECHNICAL SPECIFICATIONS

A. GENERAL

1. PROJECT OBJECTIVE

Objective of the Smart City Mission is to develop Udaipur city with core infrastructure and decent quality of life for its citizens by application of Smart Solutions, local area development and harnessing smart technologies that leads to smart outcomes. Out of the multiple proposals included in the smart city mission for urban transformation of the walled city, one of these is systematic undergrounding of the municipal utilities in the maximum possible areas of the city.

The objective behind undergrounding of municipal utilities within the duct is to reduce the action time required in attending the faults and rectifying them thus avoiding frequent digging of roads, have aesthetically good and clear skyline, ease of O&M maintenance and substantial reduction in O&M costs.

2. STUDY CONDUCTED

The Municipal Utility Services laid in / below the roads will be permanent in nature & one will be maintained only through designed and designated service duct(s) provisions and not by digging the road in decade to come. The project envisions undergrounding of overhead electrical lines and accommodating other utilities like water, OFC and Gas pipeline by constructing an underground duct. The underground duct is proposed to be constructed in the road right of way in the Walled City Area.

The total road length, as measured from the topographical survey drawings, comes out to 99 kms out of which 6.6 kms lies in the Urban Improvement Trust (UIT) area. The road width varies from 1.0 m to 15 m in the project area. Road width plays an important role in ascertaining the type of duct cross-section and, as well, also helps in deciding how many utilities (Priority wise: Power / OFC / Water / Gas) can be carried in the undergrounded duct in that stretch. There may be a case where feasibility of construction permits only one or two utilities, say Power and OFC, to be undergrounded through a “pipe duct” by HDD method and the remaining utilities water and Gas are buried directly under the ground.

Now, in case of stretches where the road width is more than 4 meters, it is possible to underground all the four utilities by laying composite RCC duct on one side of the road and having branch ducts crossing the road at pre-designed intervals to serve the consumers at other side of the road.

However, for all the stretches having road width exceeding 8 meters, techno feasible economic analysis should be carried out for two options: (1) Composite RCC duct on both sides of the road, and (2) Composite RCC duct on one side of the road and having branch ducts crossing the road at pre-designed intervals to serve the consumers at other side of the road. Ease of providing connections to the consumers on either side of the road should also be kept in mind while carrying out such analysis.

It is to be noted that in addition to these four utilities there will a sewer line in all the roads / lanes of the city, laid either at the centre / on one side of the road / both sides of the road for width more than 8 meters.

Based on the road width, an optional analysis was carried out and categorization of roads has been done vis-à-vis feasible proposals and the same is presented below:

1.	1.0 m ≤ RW < 2.0 m	Lanes, CC / Tiles	43 Km	**Proposals:** Water pipe directly buried; Power (LT) & OFC proposed to be undergrounded and shall be carried through pipe duct / RCC trench, the contractor shall study the feasibility and submit the

				report to the employer; Gas pipeline not considered at this stage.
2.	2.0 m ≤ RW < 3.0 m	Mix of CC and Bituminous	22 Km	Water pipe directly buried; Power (LT & HT) & OFC proposed to be undergrounded and shall be carried through pipe duct / RCC trench, the contractor shall study the feasibility and submit the report to the employer; Gas pipeline not considered at this stage.
3.	3.0 m ≤ RW < 4.0 m	Mainly Bituminous	14.5 Km	Water pipe directly buried; Power (LT & HT) & OFC proposed to be undergrounded and shall be carried through pipe duct / RCC trench, the contractor shall study the feasibility and submit the report to the employer; Gas pipeline not considered at this stage.
4.	4.0 m ≤ RW < 5.0 m	Mainly Bituminous	7.4 Km	**(1) For roads 4 to 4.5 in width:** Water pipe directly buried; Power (HT & LT) & OFC shall be carried through pipe duct or RCC trench; Gas pipeline not considered at this stage **(2) For roads more than 4.5 m and up to 5.0 m in width:** Water, HT, LT and OFC carried in composite RCC duct along one side of the road with provision made for Gas. Duct branching off at regular intervals to reach consumers on the other side of the road.
5.	5.0 m ≤ RW < 8.0 m	Mainly Bituminous	7.5 Km	Water, HT, LT & OFC carried in composite RCC duct along one side of the road with provision made for Gas. Duct branching off at regular intervals to reach consumers on the other side of the road.
6.	8.0 m ≤ RW ≤15.0 m	Mainly Bituminous	5.5 Km	**Option-1: (**Water / HT / LT carried in composite RCC duct along one side of the road with provision made for Gas. Duct branching off at regular intervals to reach consumers on the other side of the road. **Option-2:** (Water/HT/LT carried in composite RCC duct along both sides of the road with provision made for Gas. No duct branching and crossing.

During the field surveys, it was found that many lanes / roads while branching off from the main road are 3 to 4 m wide but after a certain distance narrow down to 1 to 2 m before exiting on the main wider road. In all such cases the duct cross-section has to be decided on the basis of the minimum road / lane width of that particular stretch.

The basic aim is to underground the utilities like Power and OFC on maximum length of the road and accommodate them in appropriate type of duct section. The possibility of none of the utilities being undergrounded is not ruled out in sections where the road / lane width is not even 1.5 m, however, this shall be dealt on case to case basis at the time of construction and the contractor shall submit the feasibility report in this regard.

Pipe duct system shall be developed depending upon the sizing requirements and site conditions.

B. SCOPE OF WORK

1. DESIGN, SUPPLY, CONSTRUCTION, INSTALLATION, TESTING AND COMMISSIONING

This Contract calls for the **design (6 months),** supply, installation, testing and **commissioning (18 months)** of the “Underground RCC Ducting system” (hereafter known as “the works”) in the “Walled city area” of

Udaipur city for accommodating municipal utilities i.e., water, power, OFC and Gas lines. The underground duct shall be constructed in the “road right of way”.

All activities (design, supply, erection, testing, commissioning) required for successful completion of the project and for faithful execution of the Contract, whether it is specifically mentioned or not in the bidding document including technical specification, schedule of rates etc, shall form part of the Contractor’s scope of work and the contracted rates are deemed to be inclusive of such activities.

A design whereby duct is situated only on one side of the road shall be preferred. Construction of underground duct shall preferably be carried along one side of the road for carrying the various types of utilities. In order to carry the utility lines to the other side of the road for providing connections to the consumers, the main duct shall bifurcate / have branch ducts at certain intervals moving across the road. These branch ducts locations shall be decided based on the electrical feeder pillars location, water supply distribution points and OFC connection points. The cross section of branch ducts may be same or different from that of the main duct cross section and shall depend upon the size & number of the utilities crossing the road like the size of water pipe may be smaller than the main pipe located in the main duct and / or the branch duct may not be carrying HT line and instead only LT line shall be required for crossing the roads. The contractor shall submit the designs and drawings to the employer for approval. The construction of duct shall be carried out based on the “Good for construction (GFC)” drawings stamped by the Employer.

The ducts (RCC composite or Pipe duct) shall carry HT & LT cables inside it and therefore the curvature of the duct at turnings / change in horizontal alignment and at bifurcations should be designed and constructed in order to take care of the bending requirements of the cables and conforms to the IEC standards and cable manufacturer’s recommendations, whichever is stringent.

The construction period shall be eighteen **(18) months** from the date of award of works.

Broadly, following works are required to be undertaken by the bidder during the construction of underground composite ducting system; however, this does not limit the liability of the bidder in taking up other works required for successful completion of the works like:

a. Site surveys and soil investigations

b. Typical duct designs proposed for various road stretches with road width varying from 1.0 m to 15.0 m and clearly stating the number of utilities that can be accommodated in each type of design cross-section. The design shall include inspection chamber locations and terminal points for duct bifurcations and connections to the consumers.

c. Methodology for providing utility connections to houses / commercial establishments / other entities.

d. Design Duct crossings at designated places for carrying utilities to other side of the road, if the proposal of laying duct on one side of the road has been adopted.

e. Shifting of utilities safely and restoring / relocating the same.

f. **Optional analysis**: Duct along one side of the road Vs both side of the road; in terms of cost, ease / difficulty in providing house service connections and O&M.

g. Road cutting and demolition of footpaths, road side drains, etc. The Construction of the duct shall be done in such a manner so that minimum obstruction is caused to the moving traffic.

h. Plain / RCC structures: includes in-situ construction as well as prefabricated RCC panels, members, etc as per the approved designs and drawings.

i. Construction and installation of inspection chambers / junction chambers.

j. Design and construction of arrangement for providing house service connections (Power / Water / OFC / Gas / all the utilities which are proposed to be carried out in duct passing through the identified street for ducting).

k. Supply, fabrication and erection of mechanical infrastructure (cable trays, MS angles, fittings, etc) for accommodating and supporting the utilities inside the duct in case of RCC composite duct and inspection chambers / junction chambers.

l. Equipment and their specifications for detecting smoke / fire / Gas inside the duct and their ICT compatibility.

m. ICT based monitoring system.

n. As-built information drawings in soft and hard.

o. One Year Defect Liability (DLP).

2. SITE PREPARATION

(i) Site clearance, preparation, excavation and trenchless works, including all temporary access provisions and site establishment, including provision and maintenance of site office.

(ii) Provision and maintenance of necessary sign boarding and hoarding for demarcation of the Works, barricading, etc during construction and testing and commissioning.

3. SITE INVESTIGATIONS

(i) Any geotechnical investigations that the Contractor may require for the purpose of designing or constructing the Works, inclusive of any soil bearing capacity analysis which may be felt necessary by the contractor. However, for information purposes it is being mentioned here that the subsurface strata consists of hard rock.

(ii) The Topographical survey map is annexed with this bid document. The contractor is required to verify the topographical survey provided by the Employer and get himself satisfied before start of any designing and execution work.

Any further Topographical surveys that the Contractor may require for the purpose of design or constructing the Works, including confirmation of existing ground levels, road crossings, electrical installations, water lines and other components of the Works shall be carried out by the contractor at his own cost.

(iii) Pre and post construction condition surveys of existing structures and services that may be affected by the Works.

(iv) Detection and identification of physical location of existing underground services, utilities, structures and obstructions along the sewer route and / or alternative routes (if any) and around the area of the Works and plotting the same on drawings.

USCL accepts no responsibility, whatsoever for inferences drawn from this data and the Contractor is deemed to have satisfied on his own responsibility as to the extent to which this information represents the conditions to be encountered.

4. PROTECTION OF EXISTING INSTALLATIONS AND UTILITIES

The Contractor shall adequately protect, uphold, maintain and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utility companies, private owners, or the Employer as appropriate.

If any damage to services results from the execution of the Works, the Contractor shall immediately:

- Notify the Employer and appropriate public authority, utility company or private owner.
- Make arrangements for the damage to be made good without delay to the satisfaction of the public authorities, utility company or private owner as appropriate. The Contractor shall be liable for all costs

for making good such damage.

The Employer may issue instructions or make other such arrangements as he deems necessary, to repair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

5. ENGINERING DESIGNS

The contractor shall carry out Basic and detailed Engineering, including preparation of Design Basis Report, Component and System Operating Philosophies, Detailed Engineering Reports, general arrangement drawings (GAD), construction drawings (GFC) and calculations as part of the works:

(i) Confirmation of proposed locations of all structures as part of the Works, including inspection chambers and house service connection chambers, distribution pillars, road crossings by the duct, duct alignments, etc.

(ii) Design of varying duct cross sections based on the right of way available.

(iii) Structural designing of the duct based on the anticipated vehicle load.

(iv) Design of duct sections at points from where house service connections are to be provided, at points from duct has to be bifurcated for crossing the road, etc.

(v) The contractor shall carryout all construction activities in accordance with the “Approved and good for construction” design and drawings stamped by the employer.

6. EXECUTION OF WORKS

6.1 CONTRACTOR UNDERSTANDS

It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the progress of the works, the general and local conditions, the labour conditions prevailing therein and all other matters which can in any way affect the works under the contract.

6.2 RESPONSIBILITY OF THE BIDDER

1. The bidder will deploy sufficient qualified technical staff for constructing the underground ducting system and the responsibilities outlined herein will remain with the bidder. The bidder is responsible to verify the qualifications of its staff and must be prepared to provide documentation of said qualifications at the request of the USCL. Minimum requirement is specified in general scope of work. In addition to this the contractor shall deploy required number and type of construction machinery required for completing the works as per the schedule. The contractor shall deploy sufficient staff during the O&M phase of the contract. The contractor shall submit the manpower deployment plan for construction as well as O&M phasing of the contract.
2. The bidder must obtain the latest revision of this document and the USCL stamped GOOD FOR CONSTRUCTION (GFC) plans before commencing work at site.
3. The Bidder shall be responsible for all costs associated with:
    a. Supply and installation of all materials necessary to construct the underground ducting system as specified in the Standard Drawings and Plans.
    b. Transportation of all materials to the job site, and the removal of all extra material from the site after completion of the works and approval of the USCL.
    c. Replacement of any materials lost or damaged after receipt of them.
    d. Supply of materials such as gravel, sand, steel, pre-cast Ferro cement RCC covers, ducting pipes and other miscellaneous construction items.

e. Arranging machinery for excavation, etc necessary for constructing the duct, pre-cast concrete covers, and other facilities as may be required in the standard drawings and plans.

4. Prior to excavation, the Bidder shall:

   a. Comply with all regulatory requirements of the USCL.

   b. Consult with the USCL about buildings, retaining walls, poles, lamp standards, landscaping or any other structures which may be endangered by the work, and provide adequate support or measures necessary to protect those items to the satisfaction of the owner / USCL.

5. The bidder shall guarantee all grades and lines. Any discrepancies between GFC plans and actual grades discovered during the final inspection shall be corrected by the bidder at the bidder's expense.

6. The Bidder shall be responsible for maintaining the backfilled excavation until all settlement has ceased.

7. The Bidder shall maintain open excavations at his or her own liability and expense, and shall also be fully responsible to minimize hazards to people and property while trenches are open.

8. When facilities of UMC, PHED and other line departments like telephone, AVVNL, etc are to be installed jointly in the same trench / composite duct, it is a responsibility of the Bidder to ensure coordination is maintained with the respective agencies.

6.3 SETTING OUT OF WORKS

The Contractor shall be responsible for the correct setting out of all works in relation to original points, lines and levels of reference at his cost. The Contractor shall execute the work true to alignment, grade, levels and dimensions as shown in the drawing and as directed by the Employer's representative and shall check these at frequent intervals. The Contractor shall provide all facilities like labour and instruments and shall cooperate with the Employer's representative to check all alignment, grades, levels and dimensions. If, at any time, during the progress of the works any error shall appear or arise in any part of the work, the Contractor, on being required so to do by the Employer's representative shall, at his own cost rectify such errors, to the satisfaction of the Employer's representative. Such checking shall not absolve the Contractor of his own responsibility of maintaining accuracy in the work. The Contractor shall carefully protect and preserve all bench marks, sight rails, pegs and other things used in setting out the work.

6.4 WORKMANSHIP AND TESTING

The whole of the works and/or supply of materials specified and provided in the contract or that may be necessary to be done in order to form and complete any part thereof shall be executed in the best and most substantial workman like manner with materials of the best and most approved quality of their respective kinds, agreeable to the particulars contained in or implied by the specifications and as referred to in and represented by the drawings or in such other additional particulars, instructions and drawings may be found requisite to be given during the carrying on of the works and to the entire satisfaction of the Employer according to the instructions and directions which the Contractors may from time to time receive from the Employer. The materials may be subjected to tests by means of such machines, instruments and appliances as the Employer may direct and wholly at the expense of the Contractor.

6.5 REMOVAL OF IMPROPER WORK AND MATERIALS

The Employer or the Employer's Representative shall be entitled to order from time to time:

a. The removal from the site within the time specified in the order of any materials which in his opinion are not in accordance with the specifications or drawings.

b. The substitution of proper and suitable materials, and

c. The removal and proper re-execution, notwithstanding any previous tests thereof or on account payments there for, of any work which in respect of materials or workmanship is not in his opinion in accordance with the specifications and in case of default on the part of the Contractor in carrying out such order, the USCL shall be entitled to rescind the contract.

6.6 EXAMINATION OF WORK BEFORE COVERING UP

The Contractor shall give 7 days' notice to the Employer or the Employer's Representative whenever any work or materials are intended to be covered up in the earth, in bodies or walls or otherwise to be placed beyond the reach of measurements in order that the work may be inspected or that correct dimensions may be taken before being so covered, placed beyond the reach of measurement in default whereof, the same shall at the option of the Employer or the Employer's Representative be uncovered and measured at the Contractor's expense or no allowance shall be made for such work or materials.

6.7 ROADS AND WATER COURSES

Existing roads or water courses shall not be blocked cut through, altered, diverted or obstructed in any way by the Contractor, except with the permission of the Employer. All compensations claimed for any unauthorized closure, cutting through, alteration, diversion or obstruction to such roads or water courses by the Contractor or his agent or his staff shall be recoverable from the Contractor by deduction from any sums which may become due to him in terms of contract, or otherwise according to law.

6.8 PROVISION OF ACCESS TO PREMISES

During progress of work in any street or thoroughfare, the Contractor shall make adequate provision for the passage of traffic, for securing safe access to all premises approached from such street or thoroughfare and for any drainage, water supply or means of lighting which may be interrupted by reasons of the execution of the works and shall react and maintain at his own cost barriers, lights and other safeguards as prescribed by the Employer, for the regulation of the traffic, and provide watchmen necessary to prevent accidents. The works shall in such cases be executed night and day, if so ordered by the Employer and with such vigour so that the traffic way is impeded for as short a time as possible.

i. Coordinate with and obtain necessary approvals from the USCL and other statutory and government authorities / agencies for successful execution and commissioning of the project.

ii. The contractor shall submit the designs and drawings to the employer for approval. All construction works shall be carried out in accordance with the design and drawings approved by the employer.

iii. Conducting geotechnical investigations that the contractor may require for the purpose of constructing the works including any soil bearing capacity analysis.

iv. Topographical survey drawings are annexed with the Tender document; however, it will be the responsibility of the contractor to confirm the levels at project site.

v. Detection and identification of physical location of existing underground utilities, structures and obstructions along the road right of way.

vi. Carry out excavations, including mobilisation of adequate numbers of supporting equipment, barricading sheets, shoring / timbering and compaction equipment for backfilling.

vii. Carrying out dewatering for all excavation works with adequate numbers and capacities of pumps. The Contractor is to note presence of fluctuating subsoil water conditions near the lake area and such along the duct alignment.

viii. Carry out diversion of flows.

ix. Provision of all necessary power, water, and material, machinery and other utilities required for Construction, commissioning.

x. Provision of all safety arrangement, facilities, hoardings and equipment to demarcate the Works and to carry out the works safely.

xi. Removal and disposal of spoil from all excavation works.

xii. Provide for necessary protection of existing structures and services during the installation of underground duct.

xiii. Supply, installation and construction of cable trays in the duct.

xiv. Design, Supply, installation and construction of precast ferro covers in case of composite RCC ducts and chambers.

xv. Reinstatement of damaged / disturbed buildings, utilities, etc.

xvi. The contractor shall engage full-time qualified Employer and other staff on site to supervise all works.

xvii. Carry out testing and commissioning for all the component of the Works.

xviii. Providing O&M Manuals for the Works.

7. REFUSE DISPOSAL

Refuse and rubbish of every kind shall be removed from the Site and disposed off by the Contractor at his own expense, frequently and regularly so as to keep the Site in an approved wholesome, hygienic and tidy condition to the satisfaction of the Employer's Representative.

8. TESTING AND COMMISSIONING

i. Provide for Testing and Commissioning of the Works, inclusive of testing and commissioning of each component of the Works and testing and commissioning of the "Underground ducting system" as a whole inclusive of all consumables, utilities & necessary materials for testing and commissioning.

ii. One year Defects Liability Period.

9. REPORTS AND SUBMISSION OF DELIVERABLES

The contractor shall submit the following reports including but not limited to:

(i) Baseline and updating of full programme for the Works.

(ii) Monthly Progress Reports.

(iii) Design Basis Report, Detailed Engineering Reports, Commissioning and Acceptance Reports.

(iv) Detailed Designs and Drawings for approval of the Employer.

(v) Operations and Maintenance Manuals for approval of the Employer.

(vi) Reports as specified in other parts of this Contract such as Construction method statements and Geotechnical Reports.

(vii) Required submittals as specified in the Contract and specifications.

(viii) As – built drawings

(ix) Any other reports as deemed required by the Employer.

10. MONTHLY PROGRESS REPORT AND CONSTRUCTION PHOTOGRAPHS

Monthly progress report shall include progress photographs for each work of construction taken from common viewpoints each month. Photographs shall show general extent of the works by both exterior and interior views. Each viewpoint will be selected and the number of monthly repetitive photographs taken from exactly the same viewpoint as decided by the Employer.

The Contractor shall provide photographs of such portions of the works, in progress and completed, in three soft copies (CDs). Each photograph shall display date and time on it. Photographs shall be properly referenced and captioned to the approval of the Employer. Some selected photographs shall be uploaded on Project Monitoring System (PMS) on regular basis.

11. AS-BUILT DRAWINGS AND GIS DATA CREATION

On the basis of the Working Drawings as approved by the EIC and after accounting any changes due to site conditions during the execution of work “As built drawing” shall be prepared by the contractor. Such drawings shall show the actual arrangements and exact locations of all ducts constructed under the Contract. The Contractor shall submit 5(five) no. of such As-Built Drawings clearly named as such to the EIC for approval before applying for the Taking-Over Certificate for the respective Section of the Works. After approval of the As Built Drawing the Contractor shall supply an electronic copy of the drawing in together with a licensed copy of the drafting software.

During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the approval to facilitate easy and accurate preparation of the As-Built Drawing.

Irrespective of the other contractual prerequisites no Section of the Works will be considered substantially completed until the respective As-Built Drawings have been approved by the EIC.

In parallel with the preparation of as-built drawings, the Contractor shall produce GIS data of the constructed works. The contractor conducts all necessary survey work, and shall ensure that vertical and horizontal measurements shall be captured at an accuracy of +/- 0.5m at a 95% confidence level, using the most suitable and cost-effective field data collection technology and methodology. All horizontal and vertical survey measurements will be referenced to the present Survey of India GIS geo reference.

The Contractor shall develop a checklist of QC checks for each type of deliverable and will be responsible for ensuring that these QC checks are performed. The Contractor shall assign a GIS quality officer to manage the quality review process. This officer shall be independent of the capture and production teams.

The Contractor shall be required to integrate the GIS deliverables with the existing data, i.e., ensure that the GIS data connects with any existing GIS system (to be updated by contractor at his own cost). This may entail revising GIS data of existing pipes at connection points. GIS data for the project will be delivered in an ArcGIS compliant file geo-database

12. CLEARANCE OF SITE

On completion of the works, the Contractor shall clear away and remove from the site all constructional plant, surplus materials, rubbish and temporary works of every kind and leave the whole of the site and works clean and in a workman like condition to the satisfaction of the Employer. No final payment in settlement of the accounts for the works shall be paid, held to be due or shall be made to the, Contractor till, in addition to any other condition necessary for final payment, site clearance shall have been affected by him, and such clearance may be made by the Employer at the expense of the Contractor in the event of his failure to comply with this provision within 7 days after receiving notice to that effect. Should it become necessary for the Employer to have the site cleared at the expenses of the Contractor, the USCL shall not be held liable for any loss or damage to such of the Contractor's property as may be on the site and due to such removal there from which removal may be affected by means of public sales of such materials and property or in such a way as deemed fit and convenient to the Employer.

C. TECHNICAL SPECIFICATIONS

1. GENERAL

This specification has been developed for use in Smart City Mission works contract. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by Udaipur Municipal Corporation (UMC), Rajasthan State Public Works Department and various contracts executed in the past on PPP / EPC models. These standard in no way imply that the bidder is allowed to construct anything other than what he / she is authorized to do in the Udaipur Municipal Corporation (UMC) construction contract package or as otherwise instructed by the UMC. These standards shall not be used for work other than for USCL as this document only applies to the underground ducting system proposed for Smart City Mission works for specific right of ways.

2. ADHERENCE TO SPECIFICATIONS AND DRAWINGS

The whole of the works shall be executed in perfect conformity with the specifications and drawings of the contract. If Contractor performs any works in a manner contrary to the specifications or drawings or any of them and without such reference to the Employer, he shall bear all the costs arising or ensuing there from and shall be responsible for all loss to the USCL.

3. MEANING AND INTENT OF SPECIFICATION AND DRAWINGS

If any ambiguity arises as to the meaning and intent of any portion of the Specifications and Drawings or as to execution or quality of any work or material, or as to the measurements of the works the decision of the Employer thereon shall be final subject to the appeal (within 7 days of such decision being intimated to the Contractor) to the Chief Employer who shall have the power to correct any errors, omissions, or discrepancies in aforementioned items and whose decision in the matter in dispute or doubt shall be final and conclusive.

4. TECHNICAL STANDARDS AND REGULATIONS

Except where otherwise specified, materials and workmanship shall comply with the requirements of the State / Central Public Works Department (CPWD) Specifications and relevant Indian Standards (hereinafter referred to as IS) issued by the Bureau of Indian Standards (BIS).

In the absence of any IS or specifications, equivalent International Standard Specifications such as those issued by the International Organization for Standardization (ISO) or British Standards (BS) or the International Electro-technical Commission (IEC) or American Society for Testing and materials (ASTM) or American National Standards Institute (ANSI) or Japanese Industrial Standards (JIS) any other international standard, specifications or Manual may be followed or proposed by the contractor at the sole discretion of the Employer or as may have been agreed in the Contract.

All standards and specifications, whether national or international, applied and used shall be with latest amendments / correction slips as available up to the date of submission of bid.

In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the contractor and submitted to the Employer for approval. The decision of Employer in such case shall be final and binding on the contractor.

In referring to the Standards, Specifications, Manuals, etc the following abbreviations are used:

1)	IS	: Indian Standard
2)	BIS	: Bureau of Indian Standards
3)	ANSI	: American National Standards Institute
4)	ISO	: International Organisation for Standardisation
5)	BS	: British Standard
6)	MORTH	: Ministry of Road, Transport and Highways

7) IEC : International Electro Technical Standards

All materials and equipment shall be new and all materials and workmanship not fully specified herein or covered by an approved standard shall be of such kind as is used in first class work and suitable to the climate in the project area. All details, materials and equipment supplied and workmanship performed shall comply with these Standards. If Bidder offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.

5. MATERIAL AND CONSTRUCTION OF DUCT

5.1 MATERIAL

The Employer shall have the right at all times to inspect the sources of all materials. Such an inspection shall be arranged and the Employer's approval obtained, prior to starting of construction. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Employer and after establishing their performance suitability based on previous data, experience or tests.

As soon as practicable after receiving the order to commence the Works, the Contractor shall inform the Employer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Employer which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep the Employer informed of orders for and delivery dates of all materials.

All raw materials including Cement and reinforcement/structural steel/pipes, etc wherever to be used by the contractor shall confirm the latest BIS/CPWD specifications. All mandatory tests as required by BIS/CPWD specifications shall be carried out and test certificates to be submitted to Employer – in charge. However, the contractor shall be fully responsible for required performances of civil/ structural work. Costs of such tests are to be borne by the contractor.

For testing of all materials, following shall be strictly adhered to:

a) All the tests shall be done in laboratories approved by Employer. The contractor is required to take written approval from Employer-in-charge, in this respect.

b) Cement and Steel shall be of a make approved by the Employer as detailed out in respective material sections of this document.

Each delivery / lot of cement and steel shall be accompanied by manufacturer / producer certificate conforming that the supplied cement and steel conforms to relevant specifications. These certificates shall be endorsed to the Employer for his record. From each lot sample shall also be taken and got tested. Cost of such tests shall be borne by the contractor. In case the test results indicate that the cement and steel arranged by the contractor does not conform to standards specified, the whole lot shall be rejected and material removed from the site by the Contractor at his cost within a week's time after written orders from the Employer.

All materials which do not conform to the Employer's Requirements shall be rejected.

5.2 CONSTRUCTION

The Construction of the duct shall be done in such a manner so that minimum obstruction is caused to the moving traffic.

Construction of duct shall be done in a neat and workmanlike manner on the locations shown on the GFC drawings. Unless otherwise directed by the Employer, the Contractor shall adhere strictly to the aforesaid drawings.

The Contractor shall be responsible for constructing the duct to the line and level required and shall ensure that the duct remains in correct alignment before, during and after finishing.

Any damage caused by the Contractor during the course of duct construction to new or existing utilities or storm water drains or structures or any part thereto, the Contractor shall at his own cost, make good, repair or replace the damage, promptly and effectively to the entire satisfaction of the Employer.

5.2.1 EXCAVATION AND BACKFILLING

The Bidder shall carry out excavation and backfilling of trenches in all kinds of soil strata such as normal soil, soft rock, hard rock for construction of the RCC duct. Unless otherwise specified all excavation shall be done by mechanical means and includes working in or under water and /or liquid mud and / or under foul positions. No blasting is allowed for any type of excavation.

In case of excavations adjacent to existing structures, care should be taken to avoid damage/settlement to existing structure. Prior information, consultation and approval of Employer should be taken while carrying out excavation near existing structures / buildings.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes and leveling the same. Excavated material should be stored as directed so as to provide necessary access for functioning of existing structures conforming to client's requirements. Rock/soil excavated shall be stacked separately as approved by the Employer. Topsoil shall be stock piled separately for later re-use.

I. Excavation

The trenches shall be dug as per route plan and detail trench drawings (indicating the various dimensions and other details of the trench) approved by the Employer for each type of soil strata. The Bidder shall take due care and precaution during excavation to avoid possible damage of other underground utilities like OFC, water and sewer lines etc and shall indemnify the USCL for all damages and shall be solely responsible for all the damages and losses. The USCL shall not be liable for any damages/losses.

For the purpose of this specification, soil strata type is defined as hard rock. No blasting shall be permitted as the works site is located in residential / commercial / heritage areas. During the construction of trenches, the Bidder shall be responsible for shoring and strutting the walls of the trench on either side by using suitable means such as wooden planks to avoid subsidence of soil. The Bidder shall also be responsible for supporting the exposed plant/facilities of other utilities such as water, electric, telephone or fiber optic cables etc to avoid any possible damage. The Bidder shall also be responsible for any dewatering of the trench during digging and construction of RCC duct.

II. Backfilling

Backfilling, in case of RCC composite ducts, shall be done in the gap between the precast RCC side walls and the excavated trench surface.

Backfilling shall normally be done with the excavated soil, unless it consists of large boulders/stone in which case the boulders/stone shall have to be broken to a maximum size of 80mm. The backfilling should be clean and free from organic matter or other foreign material. The earth filling is done with a suitable mount to allow for any shrinking of soil at the later date. In case of regular footpath, temporary reinstatement shall be done after backfilling. The left out earth if any has to be disposed by the Contractor to a suitable location as indicated by authorities at his own cost. It is advisable to start backfilling of the trench from one end and proceed along the length to the other end.

5.2.2 PLAIN AND REINFORCED CEMENT CONCRETE WORKS

PCC - M-15 Grade as a minimum

RCC - M-25 Grade as a minimum

I. Materials

a. Cement

The Contractor shall procure minimum 43 / 53 grade, unless otherwise stated separately confirming to BIS specifications, cement of reputed make such as Ultra Tech, Grasim, Birla Uttam, ACC, Gujarat Ambuja, Cement Corporation of India, Vikram, J.P. or equivalent., however, contractor shall inform in writing to the Employer the name of the make and take its approval.

Supply of cement shall be taken either in silos or in 50 Kg bags bearing manufacturer's name and BIS marking. Samples of cement arranged by the Contractor shall be taken by the Employer-in-Charge and got tested in accordance with provisions of relevant BIS codes. Cost of such tests shall be borne by the contractor. In case test results indicate that the cement arranged by contractor does not conform to be relevant BIS codes the same stand rejected and shall be removed from the site by the Contractor at his own cost within one week time of written order from the Employer.

Cement brought at site and cement remaining unused after completion of work shall not be removed from site without written permission of the Employer-in-charge.

b. Reinforcement bars & structural steel

The contractor shall procure TMT 500 reinforcement bars and structural steel conforming to relevant BIS codes of makes like SAIL, TATA STEEL, JINDAL, RASHTRIYA ISPAT NIGAM LIMITED. The Employer may authorize the contractor to purchase the same from authorized dealers of the approved manufacturers.

The mechanical properties of TMT reinforcement bars shall be as follows:

Property	**TMT 500**
0.2% proof stress / yield stress (Min. N/mm^2)	500
Percent elongation, Minimum	20 (Up to 28mm dia) & 18 (Above 26 mm dia)
Tensile strength, Minimum	8% more than the actual 0.2% proof stress but not less than 580 N/mm^2 (Up to 28mm dia) & 560 N/mm^2 (above 28 mm dia)

The contractor shall have to obtain and furnish test certificates to the Employer in respect of all supplies of steel brought by him to the site of work. Samples shall also be taken and got tested by the contractor in the laboratory approved by the Employer as per the provisions in this regard in relevant CPWD/BIS codes. Cost of such tests shall be borne by the contractor. In case the test results indicate that the steel arranged by the contractor does not conform to CPWD/BIS codes, the same shall stand rejected and shall be removed from the site of work by the Contractor at his cost within a week's time after written orders from the Employer.

The reinforcement bars, structural steel shall be stored by the contractor at site of work in such a way as to prevent distortion and corrosion. Bars of different sizes and lengths shall be stored separately.

For checking nominal mass, tensile strength, band test, re-band- test etc. specimen of sufficient length shall be cut from each size of the bar at random at frequency not less than that specified below: -

Size of Bar	**For consignment below 100 tonnes**	**For consignment over 100 tonnes**
Under 10 mm dia	One sample for each 25 tonnes or part thereof	One sample for each 40 tonnes or part thereof.
10mm to 16 mm dia.	One sample for each 35 tonnes or part thereof	One sample for each 45 tonnes or part thereof.
Over 16 mm dia	One sample for each 45 tonnes or part thereof	One sample for each 50 tonnes or part thereof.

Steel brought to site and steel remaining unused shall not be removed from site without the written permission of the Employer.

c. Quarry Materials

The Contractor shall be wholly responsible to identify the suitable sources for quarry materials required for the Works, such as earth, sand, stone, moorum, etc., and to make his own arrangements for collection and transportation of the materials irrespective of the leads and lifts required. All materials supplied by the Contractor shall satisfy the requirements set forth in the Specifications and shall be subject to the approval of the Employer.

II. Formwork

Formwork shall be properly designed for various types of loads anticipated to be imposed during the construction process. The design should also take into account the effect of vibrations created during operation of vibrators. The forms shall be capable of producing a consistent quality surface as required in the contract.

All the staging shall be of Tubular steel structure with adequate bracings or made of built up structural sections from rolled structural steel sections. Form work shall be steel or wood. Wooden form shall be made with 12 mm thick water proofing ply of approved quality.

Only one release agent shall be used throughout the entire area. Release agents shall be applied evenly and contact with reinforcement and other embedded items shall be avoided. Where the concrete surface is to receive an applied finish, care shall be taken to ensure the compatibility of the release agent with the finish.

Striking out / removal of formwork shall be done as per the approval of Employer. The surfaces of the RCC/ concrete work obtained after removal of shuttering shall be smooth and without honey combing/ pin holes, undulations and shall be such that it does not require any plastering. If at all any pin hole/ undulations are required to be made good, this shall be done with cement mortar 1:2 using coarse sand and finished smooth with steel trowel or as directed by Employer. All works damaged through careless removal of forms shall be reconstructed within 24 hours.

III. Concrete

PCC works : M-15 Design mix concrete

RCC works : M-25 Design mix concrete

The contractor shall design the concrete mix for all the RCC works and get it tested from the laboratory approved by the Employer. The testing of the design mix shall be carried out in presence of the Employer or its representative. The Contractor shall not alter the approved mix proportions or the approved source of supply of any of the ingredients without obtaining the approval of the Employer.

The mixing of concrete shall be strictly carried out in the mechanical concrete mixer of required capacity (7 - 10 cubic feet) and in no circumstances hand mixing shall be allowed. Production of concrete shall be done by weigh batching only. Volume mixing is not allowed.

The contractor shall submit method statement describing work procedure to be carried before commencing the concrete work. The method statement shall be approved by the Employer. Routine quality control tests such as slump, cube strength, sieve analysis and any other test as directed by Employer shall be done in the presence of Employer or its representative at site.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the Employer reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Employer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer.

Styrene-Butadiene copolymer latex type admixtures may be used in the design mix concrete for improving the resistance to water penetration, abrasion resistance and durability. Admixtures based on sulphonated naphthalene for producing low water cement ratio high strength design mix concrete mix are permitted with prior approval of Employer; however, the use of such admixture should not affect the workability of concrete adversely. Other admixtures, as per the requirement of site, may be used for designing the concrete mix with prior approval of Employer and after establishing its use and advantages.

IV. Construction and other types of joints

All construction joints shall be provided as recommended in BIS: 3414 and 6494 and as per minimum site requirement. Expansion joints, where required shall be provided as per BIS: 3414 Code of practice for design of joints and installation in buildings. Expansion joints of suitable gap at suitable intervals not more than 40m shall be provided in walls, floors and slabs.

V. Embedment's / Inserts in concrete work

All the miscellaneous inserts such as bolts, pipes, assemblies, plate embedment's etc., shall be accurately installed in the building works at the correct location and levels, as detailed in the approved construction drawings. The contractor will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the location of inserts as directed by the Employer. If the Employer, so directs, the inserts will have to be welded to reinforcement to keep these in place. The contractor shall be responsible for the accuracy of dimensions, levels, alignments and center lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of structure or final acceptance by the Employer.

The contractor shall ensure proper protection of all bolts, inserts, etc., from weather by greasing or other approved means such as applying white lead, putty and wrapping them in gunny bags or canvas by other means as directed by the Employer to avoid damage due to movement of his labours, material, material, equipment etc., The contractor shall be solely responsible for any damage caused to bolts inserts etc., due to negligence and in case damage does occur it shall be rectified to the satisfaction of the Employer at the contractor's cost.

VI. Grouting

The proportions of Grout shall be such as to produce a flow able mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for cleaning purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting, water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25mm	One part Portland Cement to one part sand	0.44
b) General mix	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53

5.2.3 FERRO CEMENT COVERS

The utility duct shall have Reinforced Ferro Cement covers designed for Class “AA” loading duly marked on cover with adequate steel reinforcement having thickness 150 mm anti corrosive bitumen painted MS plate Rim. The Ferro cement covers shall be of such size so that it covers the duct top cross section completely and shall have lifting hooks for removal and opening for accessing the duct.

5.2.4 CABLE TRAYS

The contractor shall be responsible for supply, erection and commissioning of the cable trays in the RCC composite duct. The cable trays shall be designed, manufactured and tested in accordance with the following standards.

1.	IS: 4759	-	HOT-DIP ZINC COATING ON STRUCTURAL STEEL AND OTHER ALLIED PRODUCTIVITY
2.	IS: 2629	-	RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL
3.	IS: 2633	-	METHODS FOR TESTING UNIFORMITY OF COATING OF ZINC COATED ARTICLES
4.	IS: 8500	-	STRUCTURAL STL-MICROALLOYED MED AND HIGH STRENGTH QUALITIES-SPEC
5.	IS:1387	-	GENERAL REQUIREMENTS FOR THE SUPPLY OF METALLURGICAL MATERIALS.
6.	INDIAN ELECTRICITY RULES 1956		

The ladder / perforated type cable tray shall be made out of Rolled sheet steel of designed thickness as per approved drawing. The tray shall be shop fabricated & the fabrication process shall include pressing, punching, slotting, drilling, welding, etc. It shall be free from burr and sharp edges. After fabrication, the trays shall be Hot Dip Galvanized as per IS: 2629 and coverage as per IS: 4759 minimum 610 gms/sqm for thickness of 75 micron zinc deposits on all points. Perforated tray dimensions: 300 mm x 100 mm x 15 mm.

Coupler plates shall be made out of 3 mm thick steel sheet and dimensions as per drawing. Coupler plates shall be hot dip galvanized conforming to IS: 4759, IS: 2629 and IS : 2633.

Contractor shall supply necessary supports and accessories for erecting the cable trays in the utility duct. Storage of cable trays and accessories shall be the responsibility of the contractor. The storage shall be done as per the recommendations of the manufacturer and relevant codal provisions.

5.2.5 DEWATERING PUMPS

The pumps shall be of non-clog submersible type required for dewatering the duct in case of flooding and discharging the flows to the nearest storm water drain. Sufficient numbers of these shall be procured and installed at suitable locations and also specified in the Bill of Quantities.

5.2.6 PIPED DUCTING

Piped ducting, wherever proposed and approved by the employer, shall be carried out using BIS certified (a) PLB HDPE pipes – for OFC laying, (b) Double Wall Corrugated HDPE pipes and RCC NP-3 pipes – for Power cables, (c) NP-3 RCC pipes and MS pipe for encasement at crossings. The contractor shall submit the method statement to the Employer for approval. All works at site shall be carried at site in accordance with the approved method statement.

I. PLB HDPE pipes, fittings and accessories, etc

The following paragraphs describe the functional requirements, major technical parameters and Type and Factory Acceptance Testing requirements for Permanently Lubricant High Density Polyethylene

(PLB HDPE) Pipe. PLB HDPE pipe shall be suitable for underground fibre optic cable installation by blowing as well as conventional pulling. The PLB HDPE pipe shall be suitable for laying in trenches by directly burying and laying through MS/RCC pipe at crossings as well as laying through no-dig technology. The expected service life of HDPE pipe and accessories shall not be less than 30 years. Documentary evidence in support of guaranteed life span shall be submitted by the Contractor during detailed engineering.

The unit rates quoted in the price schedule shall be the composite price of PLB HDPE pipe along with all accessories and laying complete i.e., excavation, providing, laying, jointing, testing, backfilling, etc complete. The duct diameter sizes expected to be utilized are 32/26, 40/33 & 50/42.

The PLB HDPE pipe shall have two concentric layers viz. outer layer and inner layer. The outer layer shall be made of HDPE material and the inner layer of solid permanent lubricant.

These concentric layers shall be co-extruded and distinctively visible in cross-section under normal lighting conditions and generally conform to IS-9938. In the finished PLB HDPE pipe, the coextruded inner layer of solid permanent lubricant shall be continuous and integral part with HDPE outer layer and preferably be white in color. The inner layer of solid permanent lubricant shall not come out during storage, usage and throughout the life of the pipe. The pipe shall be supplied in a continuous length of 1000 (one thousand) meter in coil form, suitable for transportation, installation and handling purposes. The finished pipe shall be of good workmanship such that the pipe is free from blisters, shrink holes, flaking, chips, scratches, roughness, break and other defects. The pipe shall be smooth, clean and in round shape, without eccentricity. The ends shall be cleanly cut and shall be square with axis of the pipe.

Associated accessories & tools (but not limited to these only):

1. Plastic Coupler: To join two duct lengths – air tight and water tight
2. End Plug: To seal duct ends prior to the installation of cable
3. Cable sealing Plug: To seal duct ends after insertion of the cable
4. End cap: Made of hard rubber, fitted on both ends of duct coil after manufacturing.
5. Duct cutter: To cut duct cleanly and with square ends.
6. C spanner: To tighten plastic coupler.
7. Etc.

The PLB HDPE pipe shall conform to the following standard and the technical specifications described in the following sections.

a) IS: 4984 / IS: 2530/IS:14151/(part1)/ IS:9938/IS:7328/IS12235(Part-9)/IS:5175
b) b) ASTM D 1693/ ASTM D 638/ ASTM D 648/ ASTM D 790 / ASTM D 1712/ ASTM D 2240/ ASTM D 4565 / ASTM F 2160/ ASTM G 154
c) TEC-spec no. GR/CDS-08/02/NOV-04(including all amendments)-HDPE pipe for use as duct for optical fibre cable.

II. Double Wall Corrugated pipes, fittings and accessories etc.

This section specifies the requirement and testing for double wall corrugated (DWC) HDPE ducts buried underground including ducts fittings and protection wherever required for carrying HT, LT and distribution cables inside. This specification requires references to the following specifications:

(i)	IS:14930 Pt.-I	General requirements of Conduit system for Electrical and Communication installation.
(ii)	IS:14930 Pt. II	Particular requirement of Conduit system for Electrical and Communication installation.

(iii)	IS:2530	Method for test for polyethylene moulding materials and polyethylene compounds.
(iv)	IS: 7328	HDPE materials for moulding and extrusion.
(v)	IS: 12063	Classification of degrees of protection provided by enclosures of electrical equipment.
(vi)	IS: 11000 (Pt-2/Sec1)	Glow Wire test and Guidance, test methods for fire hazard testing
(vii)	ASTM D 1693	Test method for environmental stress – cracking of ethylene plastics.
(viii)	ASTM D 638	Standard test method for tensile properties of plastic
(ix)	ASTM D 790	test method for flexural properties of Unreinforced and reinforced Plastics and Electrical insulating Materials
(x)	ASTM D 2240	Standard test method for Rubber Property.
(xi)	ASTM D 648	Standard test method for deflection temperature of plastic under flexure load in the Edgewise Position.

The dimensions of the pipe and tolerances shall be as given below:

Nominal Size (mm)	Outside Diameter (mm)	Outside Diameter Tolerance (mm)	Minimum Inside Diameter (mm)
90	90	+1.7	74
110	110	+2	94
120	120	+2.2	102
125	125	+2.3	105
145	145	+2.7	122
160	160	+2.9	134
180	180	+3.3	151
200	200	+3.6	174
225	225	+4.1	195
250	250	+4.5	216
315	315	+5.7	268

The unit rates for construction of duct shall include excavation, providing, laying, jointing, testing, backfilling, etc complete.

III. Duct encasing at crossings / over the bridges & culverts, etc

The HDPE ducts carrying OFC and Power cables shall be encased inside RCC NP-4 or MS pipes at locations like road crossing, bridge crossings, culverts, etc.

Mild Steel (MS) encasing pipes shall be of required diameter as per IS 1239 (Heavy Class).

Encasing pipes shall be of required diameter and strength so as to accommodate the duct in such a manner that sufficient clearance is maintained all around the HDPE duct and during maintenance or breakage the duct can be easily pulled out. The encasement pipes shall be either of the two materials i.e., **(1)** Mild Steel tubes (Heavy Class) conforming to IS 1239, and **(2)** RCC NP-4 spun pipes conforming to IS 458.

The unit rate shall include: excavation (if laid underground), supporting (if laid above ground), providing, laying, jointing, pulling the duct inside the casing pipe, backfilling (if laid below the ground), testing the supports (if laid above the ground), testing, etc complete in all respects and ready for use.

5.2.7 INSPECTION CHAMBERS / JUNCTIONS

Inspection chambers and junctions shall be provided at every 30 m intervals for RCC composite duct as well as for piped ducts. In addition, Junctions / Chambers shall be provided at locations along the underground duct for OFC connectivity to the consumers and a separate map showing such locations are attached.

NOTE: Wherever any Brand name is mentioned as a benchmark for Quality, it should be read as "BRAND NAME OR EQUIVALENT" for all the items mentioned in different Sections of this Document.

SCADA for Dewatering Pumps in Underground Duct

SCOPE OF WORK & TECHNICAL SPECIFICATIONS: It is provided in Section VI separately of this bid document.

Section-5E

Roads and Storm Water Drains

1. Objective

Roads perform certain basic functions in the built environment such as providing routes for vehicles and public transport, and accommodating utility services and drainage systems. The design of roads affects how successful it is in performing these functions, and it can also vitally affect the urban character of a neighborhood and influence how people use the roads and interact with each other on it. Under the current project, the identified roads in Walled City Area have been taken up to the aspects of usable and friendly roads. It is proposed to undertake Redesigning of the roads and side storm water drains, retrofitting of the footpath and roads, junction redesigning, etc. amongst other improvements on the roads.

2. Scope of work

The total scope of work comprises of civil works

The ABD envisions undergrounding of overhead electrical lines and accommodating other utilities like water, OFC and Gas pipeline by constructing an underground duct. The sewer line work shall also be simultaneously undertaken along with undergrounding of the utilities. It is evident that during the laying of underground infrastructure facilities like water, sewerage, duct, etc the road / pavements shall be dismantled and excavation shall be carried out and the same has to be re-laid once the laying of utilities is completed on various stretches of the road. The contractor shall design and provide road furniture like road markings, signs, indicators, etc as mentioned in the BOQ. During this process the road side storm water drains will get damaged and therefore their restoration is also essential. At many places in the walled city area the size of drains are found to be insufficient and therefore this needs to be reconstructed after dismantling. Many of such drains are found to be heavily silted and there is every possibility that during removal of the silt these are bound to be damaged. This integrated infrastructure project provides us an opportunity to re-design and reconstruct the drains. The bidder / contractor shall carryout design of all the road side storm water drains as per the CPHEEO norms. The scope of work includes the following:

Therefore, this provides an opportunity to consider redesigning the:

i. Road Sections and junctions designing.
ii. Road side Storm water drains designing.
iii. Road Furniture.
iv. Dismantling and reconstruction of storm water drains as per the approved design.
v. Road relaying / construction.

The city roads having various widths, width of those roads vary from 0.5 to 15m, for the continence these are categorized into six types of roads according to their width. Up to 5m wider roads have

to to be constructed as CC roads based on the guidelines of IRC SP 62-2014 and beyond wider then these roads shall construct with BT roads based on the guidelines of IRC 37-2012. Through the city junctions shall be improve as to reduce conflict points, for this junction improvement shall be depend on major and minor type of junction. Minor junctions shall develop by providing the road furniture like GIVE way, STOP sign boards, and road markings. Major junctions shall develop by signalization and rotary construction depending on the available land and traffic at the junction. The list of junctions has been presented in this document, Bidder shall develop the intersections according to the given list.

The all type of roads shall have with minimum lateral gradient to drain out the storm water from the surface of the pavement, to collect this storm water storm water drains shall be provide at both sides, with suitable dimensions, for effective utilization of the ROW surface of the drain shall be allowed the vehicular movement or pedestrian movement based on the guidelines given in this manual, for that surface of the drain shall be covered with Ferro cement covers suitable for handling class-A loading.

All roads of the city shall be provided with the effective road furniture, like road markings, cat eye, footpath marking, stop weight strips and so. The all intersections shall be provided with markings of road markings, zebra crossing and other necessary markings, those intersections shall be provided with sign boards like STOP and GIVE way marking, Prohibition for parking halting and so. For the clear visibility cat eye shall be provided at the intersection.

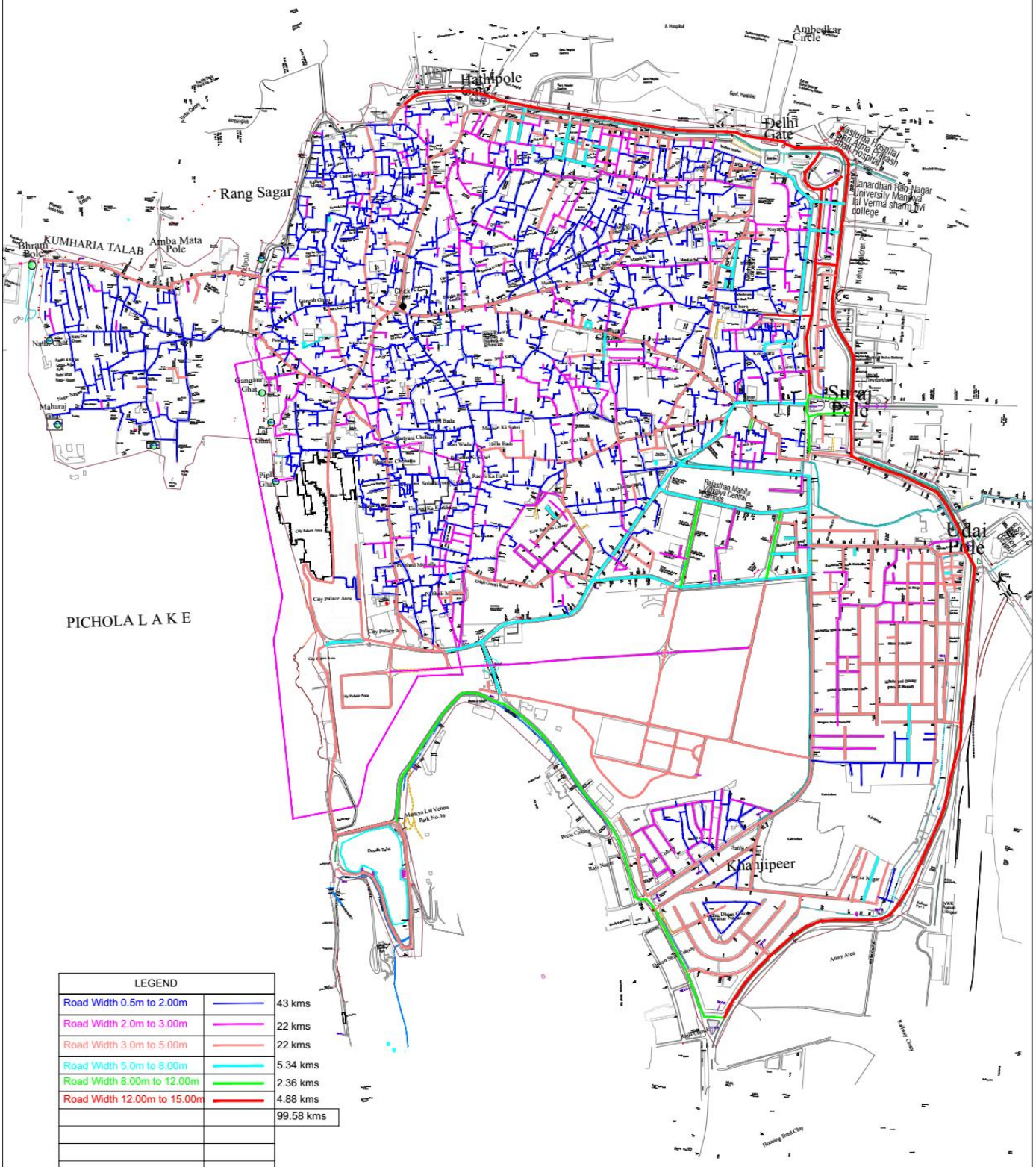
Entire road section shall be provided with the center lane, border lane marking, and so shall be provided and for clear visibility cat eyes shall be provide with suitable spacing, for these marking standard guidelines of IRC-35-1997 or latest IRC specification shall be adopted. At all curves and necessary locations shall be provide the sign boards of prohibition and cautionary sign boards according to standard IRC specifications.

The smart components work is being done through another package. Since these are inter-related works, both the successful bidders need to coordinate their work for the successful completion of both the projects. However, the package 1 Contractor will be the Main Contractor. There will be interaction meetings by the client which will be mandatorily attended by both the contractors. The site of the project Udaipur Smart City Roads comprises of Different widths of Road

Note: Lengths given in the below table are approximate. Actual length at the site may vary. Change of scope will be considered when length is more than 10%.

S.No	Approximate Width of Roads	Approximate Length (Km)
1	0.5< RW<2	43
2	2<RW<3	22
3	3<RW<5	22
4	5<RW<8	5.34
5	8<RW<12	2.36
6	12<RW<15	4.88

ROAD MAP OF WALL CITY



LEGEND		
Road Width 0.5m to 2.00m		43 kms
Road Width 2.0m to 3.00m		22 kms
Road Width 3.0m to 5.00m		22 kms
Road Width 5.0m to 8.00m		5.34 kms
Road Width 8.00m to 12.00m		2.36 kms
Road Width 12.00m to 15.00m		4.88 kms
		99.58 kms

List of Intersections and its Approximate Area: (Any change in area of Intersection can't be considered as Change of Scope.)

Intersection No	Intersection	Type	Classification	App. Area (sq m)	Recommended improvement	Remarks
1	Gayatri kiryana	Y	Major	370	Signalization	3-legged
2	No name	T	Minor	70	Minor intersection	
3	Prernaplayway school	4legged (Y & T)	Minor	450	Minor intersection	
4	Hathipole gate	Multy legged	Major	2850	Signalization	
5	Pyau	T	Minor	100	Minor intersection	
6	Raja chowk	4 legged	Minor	80	Minor intersection	
7	Police chowk	Staggered	Minor	150	Minor intersection	
8	Chhatrioko chowk	T	Minor	220	Minor intersection	
9	Jodhpur misthan	+	Minor	550	Minor intersection	
10	Delhi gate	Multy legged	Major	2600	Rotary	
11	Bapubazar1	Y	Minor	300	Minor intersection	
12	Bapubazar2	4 legged	Major	800	Signalization	4-legged
13	Bapubazar3	Y	Minor	500	Minor intersection	
14	Bapubazar4	4 legged	Major	1400	Signalization	4-legged
15	Chokhala bazaar	Multy legged	Minor	65	Minor intersection	
16	Nalwayachowk	Multy legged	Minor	150	Minor intersection	
17	Bhram pole	+	Minor	180	Minor intersection	
18	Ishwarniwas	Y	Minor	100	Minor intersection	
19	Jagnathmarg	4 legged	Minor	180	Minor intersection	
20	Ganesh ghati	+	Minor	50	Minor intersection	
21	Clock tower	Staggered	Major	550	Signalization	4-legged
22	Nichlamochiwara	4legged intersection (Y&T)	Minor	160	Minor intersection	
23	Lakharachowk	Staggered	Minor	50	Minor intersection	
24	Bapubazar5	Multy legged	Major	1600	Rotary	
25	Queen café restaurant	+	Minor	30	Minor intersection	
26	Panduwara	X	Minor	120	Minor intersection	
27	Mukharjichowk	+	Minor	220	Minor intersection	
28	Jagadish chowk	Multy legged	Minor	90	Minor intersection	

29	Jagadish temple intersection	Multy legged	Major	360	Signalization	5-legged
30	Ziniretchowk	+	Major	100	Signalization	4-legged
31	Shreeji remedies	Multy legged	Minor	765	Minor intersection	
32	Suraj pole	Multy legged	Major	4200	Rotary	
33	Hotel new jyoti	T	Major	950	Signalization	3-legged
34	Gulabbagh road chawrastha	Staggered	Major	675	Signalization	3-legged
35	Police station suraj pole chawarstha	Multy legged	Major	1000	Signalization	5-legged
36	Pichhorimohalla	Staggered	Minor	260	Minor intersection	
37	Hotel motimahal	+	Minor	180	Minor intersection	
38	Udaipur bus station chawrasta	Multy legged	Major	5000	Rotary	
39	Vishwakarma travels	Multy legged	Minor	200	Minor intersection	
40	Kalajigoraji temple	X	Major	750	Signalization	4-legged
41	Hotalgulabbag	+	Minor	1300	Minor intersection	
42	Gold leaf hotel	T	Minor	250	Minor intersection	
43	City palace area	Y	Minor	250	Minor intersection	
44	Hotel pannadhay palace	Multy legged	Minor	370	Minor intersection	
45	Ranganiwas palace hotel	T	Major	240	Signalization	3-legged
46	Bhairuji temple	4 legged	Major	260	Signalization	4-legged
47	Roshanlal Sharma public sec. School	+	Major	80	Signalization	4-legged
48	Khanaji peer chawrasta 2	Staggered	Minor	225	Minor intersection	
49	Doodhtalai	T	Minor	170	Minor intersection	
50	khanaji peer chawrasta 1	T	Major	960	Signalization	3-legged
51	Rajjachowk (Patel circle)	Y	Major	5000	Signalization	3-legged
52	Ahriantfoma center	4 legged	Minor	180	Minor intersection	
53	Bulaki ka chowk	Multy legged	Minor	110	Minor intersection	
54	Vyas bhawan	Staggered	Minor	225	Minor intersection	
55	Nathi ghat chowk	Staggered	Minor	40	Minor intersection	
56	Madhanmohanmathu radhish temple	Y	Minor	70	Minor intersection	
57	Mathonkisahri	T	Minor	70	Minor intersection	
58	Khairwada hanuman chowk	X	Minor	80	Minor intersection	
59	Mahaveerbhavancho wk	T	Minor	100	Minor intersection	

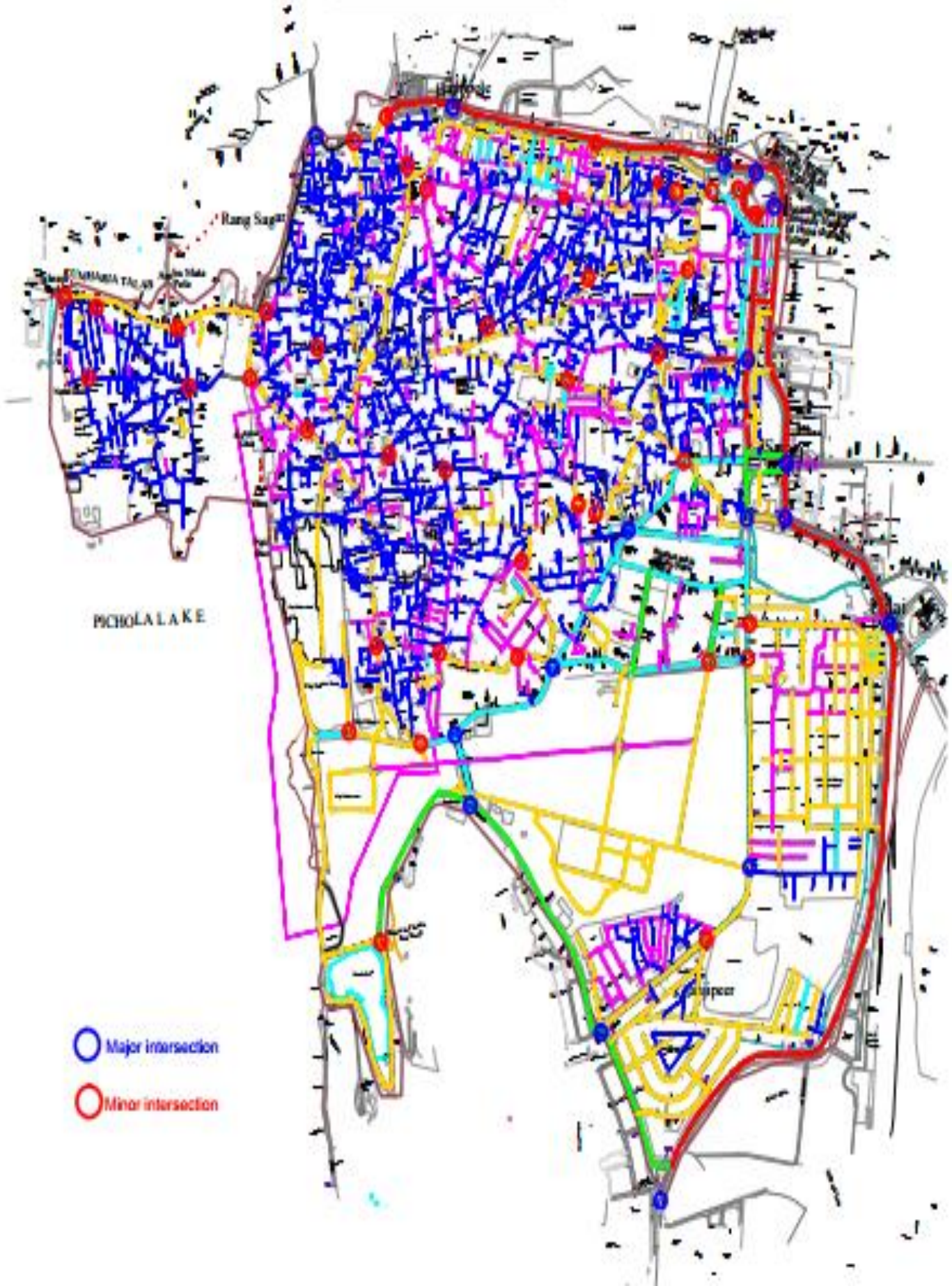
60	Naiyonkitalai	Y	Minor	600	Minor intersection	
61	Gopalbhavan	X	Minor	120	Minor intersection	

Summary of Intersections

Note: Any change in type of Intersections can't be considered as change of scope.

Minor intersections	41
3-legged signalized intersections	6
4-legged signalized intersections	7
5-legged signalized intersections	3
Rotary	4
Total number of intersections	61

Intersection map of Wall city



3. Technical specifications

Manual of Specifications and Standards for Four Laning of Highways (IRC: SP: 84-2014) and Standards for Two Laning Highway (IRC SP:-73-2015), referred to herein as the Manual. All Materials, works and construction operations shall conform to the Manual of Specifications and Standards for Four -Laning of Highways (IRC:SP: 84-2014) and Manual of specifications and standards for Two Laning, referred to as the Manual, and MORTH Specifications for Road and Bridgeworks 5th Revision 2013.

In the absence of any definite provisions on any particular issue in the aforesaid Specifications, reference may be made to the latest codes and specifications of IRC, BIS, BS,ASTM, AASHTO and in that order. Where even these are silent, the construction and completion of the works shall conform to sound engineering practice as approved by the Authority's Engineer.

3.1 Pavement Design

Proposed pavement shall be both of Rigid pavement as well as Flexible pavement type. Pavement design of Rigid pavement shall be as per IRC: SP: 62-2014 Guidelines for the design and construction cement concrete Pavements for Low volume roads. Rigid pavement for new pavement or for widening and strengthening of the existing pavement shall be designed for a minimum design period of 20 years. Stage construction shall not be permitted. Pavement design of Flexible pavement shall be as per IRC: 37-2012 Tentative Guidelines for the Design of Flexible pavements.

3.2 Use of Plastics in Bituminous Mix:

Roads that are constructed using plastic waste are known as Plastic Roads and are found to perform better compared to those constructed with conventional bitumen. Further it has been found that such roads were not subjected to stripping when come in contact with water. It also increases the strength and performance of the road. Plastic increases the melting point of bitumen and hence mixing can be done in more better and easier way. Inclusion of plastic waste in road construction eliminates the plastic shrinkage cracking of road surface and reduces the drying shrinkage to some extent. In hot and extremely humid climate durable and eco-friendly plastic roads are of greatest advantages. This will also help in relieving the earth from all type of plastic waste. Considering all the advantages it is advised to use waste plastic material in Bituminous Mix.

3.3 Footpath

Universal Accessibility guidelines will be followed in designing the foot path. The obstruction generally experienced in pavements will be suitably moved so that uninterrupted movement can be achieved. Footpath design shall be as per IRC: 103-1988. For this design shall be adopt paver blocks like checkered tiles to sustain 20 years. Pedestrian Guard rails shall be provided at appropriate locations based on site requirement. Landscaping at Islands of intersection locations shall be done as per IRC: SP-84-2014.

3.4 Storm water drains

The bidder shall carryout the storm water drain design for the ABD area as per the CPHEEO norms. The designs should be such that water does not stagnate on the roads. The contractor shall submit the designs and drawings to the EIC for approval and carryout the construction works as per the approved designs and drawings. The drains shall be provided with fit to size perforated ferro cement covers for covering the drains.

3.5 Signs and Variable Signs

Traffic signs and pavement markings shall include but not limited to road signs, full gantries, overhead signs, Mounted signs, road markings, cat-eyes, Variable Signs and chevron marking boards. The location of these provisions shall be finalized in consultation with Authority Engineer.

3.6 Cat eyes (Road Studs):

Cat eyes shall be provided all along the both edges of Carriageway and adjacent to the median edge on both sides of the highway and all Major and Minor Junctions. The signage is an important element of road. The letters size, size of the board, reflective sheeting etc., shall be as per the IRC 67-2012.The Reflective Pavement Markers (RRPM) i.e. road studs shall be provided to improve the visibility in night time and wet weather conditions. These shall be prismatic retro reflective type conforming to ASTM D 4280. The Table presents the warrants for providing Road studs in two lane highway and the priorities to be followed along with placement details shall be as per IRC: 35-2015.

3.7 Road Markings:

As per IRC:35 - 2015 Longitudinal Pavement markings are lines placed along the direction of traffic for the purpose of indicating to a driver, his proper position on the roadway. Broken lines are permissive in character and may be crossed with discretion, if traffic permits. Solid lines are restrictive in character and indicate that crossing is not permitted except for entry or exit from a premises or a side road or to avoid a stationary object. Double solid lines indicate maximum restrictions and are not be crossed except in emergent usage.

On unimportant roads with less than 5 meters wide carriageway, center lines are considered undesirable as these entail discomfort and hazard. In such cases, short section of center lines may be provided on approaches to busy intersections, pedestrian crossings, horizontal and summit curves with restricted sight distances and on locations where driver visibility is reduced e.g.by frequent fogs.

3.8 Bituminous pavement design using Waste plastic:

Bidders shall design the flexible pavement by using the waste plastic as the raw material which will improve the binding property of mix as well as makes the mix impervious. Bidders shall be proceeded with the dry process for mixing of the waste plastic with bituminous mix, waste plastic shall add to hot aggregate before addition of bitumen to the aggregate. Bidder shall adopt optimum plastic content for blending the bitumen in the construction of flexible pavement by using waste plastic. Bidder shall follow IRC: SP: 98-2013 Guidelines for use of waste plastic in Bituminous mix, for designing of this bituminous mix adding waste plastic.

4. Final acceptance and Testing

4.1 Schedule for Tests

The Contractor shall, no later than 30 (thirty) days prior to the likely completion of construction, notify the Authority's Engineer and the Authority of its intent to subject the Road to Tests, and no later than 10 (ten) days prior to the actual date of Tests, furnish to the Authority's Engineer and the Authority detailed inventory and particulars of all works and equipment forming part of Works.

The Contractor shall notify the Authority's Engineer of its readiness to subject the Project road to Tests at any time after 10 (ten) days from the date of such notice, and upon receipt of such notice, the Authority's Engineer shall, in consultation with the Contractor, determine the date and time for each Test and notify the same to the Authority who may designate its representative to witness the Tests. The Authority's Engineer shall thereupon conduct the Tests itself or cause any of the Tests to be conducted.

4.2 Tests

Visual and physical test: The Authority's Engineer shall conduct a visual and physical check of construction to determine that all works and equipment forming part thereof conform to the provisions of this Agreement. The physical tests shall include tests (to be decided with Authority's Engineer at the time of physical tests as per relevant IRC/ Code Manual).

Riding quality test: Riding quality of each lane of the carriageway shall be checked with the help of a calibrated bump integrator and the maximum permissible roughness for purposes of this Test shall be 2,200 (two thousand two hundred) mm for each kilometer.

Other tests: The Authority's Engineer may require the Contractor to carry out or cause to be carried additional tests, in accordance with Good Industry Practice, for determining the compliance of the Project road with Specifications and Standards.

Environmental audit: The Authority's Engineer shall carry out a check to determine conformity of the Road with the environmental requirements set forth in Applicable Laws and Applicable Permits.

Safety Audit : The Authority's Engineer shall carry out, or cause to be carried out, a safety audit to determine conformity of the Project Highway with the safety requirements and Good Industry Practice.

4.3 Agency for conducting Tests

All Tests set in this document shall be conducted by the Authority's Engineer or such other agency or person as it may specify in consultation with the Authority.

4.4 Completion Certificate

Upon successful completion of Tests, the Authority's Engineer shall issue the Completion Certificate in accordance with the provisions of client.

5. Resources requirements

The requirements mentioned in general scope of work shall be fulfilled by the bidders for entire completion of the project.

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

6.2 Insurance: The minimum amount of Third Party Liability insurance cover shall be *Rs 10,00,000 (Rupees ten Lakhs only)* per occurrence or event, with the number of occurrences not less than four. The Contractor shall promptly notify the Project Manager of each claim made under the Third Party Liability coverage, and shall renew the Third Party Insurance after each such occurrence in order to maintain the number of covered occurrences at not less than four.

The minimum coverage against damage to the Works and materials during construction shall be *Rs. 5,00,000 (Rupees Five Lakhs only).*

6.3 Site Investigation Reports: The Contractor, in preparing the Bid, shall rely on any Site Investigation Reports referred to in the PCC**,** supplemented by any information available to the Bidder.

6.4 Contractor to Construct the Works: The Contractor shall construct and install the Works in accordance with the Specifications and Drawings.

6.5 The Works to be completed by the Intended Completion: The successful bidder will be expected to complete the works within 18months from the Start Date, which shall be the date of issue of the Notice to Proceed or such other Start Date as may be specified in the Notice to Proceed.

6.6 Designs by Contractor and Approval by the Project Manager: The scope to carry out designs & drawings are as specified in scope of work in this document.

6.7 Safety: The Concessionaire shall submit the Safety Manual covering all the components of the scope of work to be strictly followed during implementation.

7 Machinery requirements:

7.1Paving Equipment: The construction of Pavement shall conform to the provisions to clause 602.9 of standards and specifications of Indian Roads Congress (MORTH) Fifth Revision-2013.

Wherever possible concrete shall be placed with an approved "SLIP FORM PAVER" with independent units designed to (i) spread, consolidate, screed, and float finish, (ii) texture and cure the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary and so as to provide a dense and homogeneous

pavement in conformity with the plans, standards and specifications. The paver shall be equipped with electronic sensor controls to control the line and grade from either one-side or both sides of the machine. Fixed form pavers shall not be permitted.

Vibrators shall operate at a frequency at 8000-10000 impulses per minute under load at a maximum spacing of 600 mm. The variable vibration setting shall be provided in the machine.

Construction with “SLIP FORM PAVER” shall be executed as provided under clause 602.9.5 of IRC standards and specifications (MORTH) FIFTH Revision-2013.

Slip form paving machines shall have vibration of variable outputs with a output of not less than 2.5 kw per meter width of slab per 300 mm depth of slab for a laying speed up to 1.5 m per minute. The machines shall be sufficient mass to provide adequate reaction during spreading and paving operation on the traction units to maintain forward movements during the placing of concrete in all situations. Normal paving speed shall be maintained as per clause 602.9.1.

SLIP form paver shall be equipped with Dowel Bar Inserter (DBI) for automatic dowel bar insertion. Methodology shall conform to clause 10.1.5 of IRC: 15-2011.

To proceed for construction of flexible pavement bidders should hold with the fallowing equipment:

Hot mix plant with electronic control of min. 30-40 ton/hr capacity (owned / leased)	1
Sensor Paver finisher	1
Front End loader 1 Cu.m Capacity	2
Vibratory roller 8/10 T capacity	1
Tipper 10 T capacity	5
Tandem Roller	1
Batch Mix plant and TM	1
Screed, Plate and needle vibrator	5 set
Generator	2
Floater and Dewatering pump	5 set

8 Specifications and Standards required for construction

Pavement Performance Requirements

Roughness: In each lane measured by calibrated BI: Not more than 2000 mm/km for each lane in a km length.

For Urban roads, minimum design speeds are as follows: Arterial-80kmph, Sub Arterial-60kmph, Collector Street-50kmph and Local streets-30kmph.

Minimum radii of horizontal curves:

Design speed in kmph	Minimum radius when super elevation is limited to (in meters)	
	7 per cent	4 per cent
30	30	40
50	90	105
60	130	150
80	230	265

Utility corridor: 1.1m strip of land at extreme edge of ROW for roads wider than 5m

Field Laboratory:

Within 15(Fifteen days) from the date of commencement of work the Contractor shall arrange to provide 250 sqft. Size a fully furnished and adequately equipped field laboratory as per Specifications and directions of the Project Manager, including maintenance of the same. This shall be removed at the completion of the work. All dismantled items of field laboratory and all equipment shall be property of the Contractor at the completion of the work. The Laboratory shall be functional till the work is completed. If Project Manager found that Laboratory arranged by the Contractor is not being maintained properly then Project Manager has right to deduct a reasonable amount from payment. The construction of Field Laboratory & its maintenance is incidental to the work.

The calibration of the laboratory equipment and instruments shall at the initial stage to be certified by agencies approved by the Project Manager. Laboratory equipment shall be properly maintained and calibrated throughout the period of the Contract by the Contractor at his own expense. The Contractor shall notify the Project Manager in sufficient advance prior to conducting any tests for the materials and work. The Project Manager will also inspect the laboratory and the contractor shall provide adequate facilities to the Project Managers for his independent verification of the accuracy and adequacy of the facilities.

Indicative List of Laboratory Equipment Required

S No	Details
1	Compression Testing machine 100 MT capacity – 1 nos
2	Slump cone (2 nos)
3	Gauge to measure thickness of coating
4	Measuring tape (4 nos of steel) , vernier scale, water tank for curing (2 nos), thermometers, vibrating platform, tools and tackles, etc
5	Leveling instrument (Auto levels of standard BIS manufacturer)
6	Compass
7	Balance (2 type) volume measuring apparatus & hand tools etc.
8	BIS Sieves, sieve shaker and hydrometer – 1 set each for Coarse and Fine aggregates
9	Sand replacement cylinder and core cutter – 1 set
10	Cylinder and cube moulds (Minimum 12 nos), Cylinder moulds for Marshall stability (Minimum 12 nos)
11	Measuring instruments
12	Instant Moisture meter
13	Ultrasonic density meter
14	Leveling staves (Aluminum) – 3 nos minimum

15	Compression testing machine for testing mortars and bricks etc – 1nos
16	Plastic measuring cylinder for Silt content of fine aggregate – 1 nos
17	Bitumen content test equipment
18	Marshal stability equipment
19	Bitumen penetration test equipment
20	Specific gravity testing equipment (Piconometers-2 nos, Wire basket-2 nos)
21	Oven of minimum temperature holding capacity of 200°C
22	Water bath of holding temperature capacity between 0°C to 60°C
23	Bitumen pavement density testing equipment
24	Impact Value test for aggregates
25	Flakiness and elongation test for aggregates

NOTE: Wherever any Brand name is mentioned as a benchmark for Quality, it should be read as "BRAND NAME OR EQUIVALENT" for all the items mentioned in different Sections of this Document.

Pre-Construction Inspection, Testing & Review of Data for Materials, Plant & Equipment:

The contractor shall place order for the material and the equipment only after the approval of the Project Manager. The Contractor shall submit the detailed drawings for the approved manufacturer and the procedure of submission, review and revision shall be specified herein below.

The Contractor shall inform the Project Manager about the likely dates of manufacturing, testing and dispatching. The Contractor shall notify the Project Manager for Inspection and Testing, at least twenty eight days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates. The Project Manager will decide whether he or his representative will inspect and test the material/ equipment or whether he will approve it on the basis of manufacturer's certificate.

Supply of Colored Record Photographs: The Contractor shall, at his own cost, arrange to take color photographs at various stages / facets of the work including interesting and novel features of the work as directed by the Project Manager and supply two copies of color record photographs mounted in the albums including negatives with specification and these shall be kept by Employer.

Public Awareness / Information Display: The Contractor shall, at his own cost, arrange to provide, erect and maintain necessary display boards/ banners etc. at selection points of project site giving such information as considered necessary for public awareness/ information/ safety as directed by the Project Manager.

Contractor's Responsibilities: The contractor shall promptly inform the Employer and the Project Manager of any error, omission, fault, or any other defect in the design or drawings or specification for the works, which he discovers when reviewing the contract documents, or in the process of execution of the works. The Project Manager will resolve the ambiguity or correct the error and will notify the contractor of the interpretation to be adopted.

Services: Underground and overhead services are likely to be met with during construction. These are to be protected against damage by the Contractor at his own cost.

The contractor shall be required to carry out removal / shifting of existing utilities as itemized in the BOQ. The contractor work program shall include this activity. The work shall be carried out under supervision of concerned department. The supervision charges of the line agencies shall be paid by the contractor and shall be reimbursed on actual on submission of receipt.

Shifting of underground and overhead services other than itemized in the BOQ, but falling in the alignment of pipe line will have to be done by Contractor. The employer would provide full support to contractor in coordinating with line agencies; however no claim on account of delay in shifting of utilities by line department will be admissible.

Engagement of Staff and Labor: Except as otherwise stated in the Specification, the Contractor shall make arrangements for the engagement of all staff and labor, local or otherwise, and for their payment, housing, feeding and transport.

The contractor shall pay equal wages for men and women for work of equal value or type.

The Contractor shall provide and employ on the Site in the installation of the Facilities such skilled, semi-skilled and unskilled labor as is necessary for the proper and timely execution of the Contract. The Contractor is encouraged to use local labor that has the necessary skills.

The Contractor shall be responsible for obtaining all necessary permit(s) and/orVsa(s) from the appropriate authorities for the entry of all labor and personnel to be employed on the Site into the country where the Site is located. The Employer will, if requested by the Contractor, use his best endeavors in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national or government permission required for bringing in the Contractor‘s personnel.

The Contractor shall at its own expense provide the means of repatriation to all of itsand its Subcontractor‘s personnel employed on the Contract at the Site to the place where they were recruited or to their domicile. It shall also provide suitable temporary maintenance of all such persons from the cessation of their employment on the Contract to the date programmed for their departure. In the event that the Contractor defaults in providing such means of transportation and temporary maintenance, the Employer may provide the same to such personnel and recover the cost of doing so from the Contractor.

Be required to employ at least 50% of the labor force from communities within a radius of 2kms from the site, if sufficient people are available.

9. Time schedule

Project shall be partitioned into three parts:

1. **Design period** of **6 Months**,
2. **Execution period** of **18 months** from the Appointed Date,
3. **Defect Liability Period** shall be done for **1 year.**

SECTION V-F

SUPERVISORY CONTROL & DATA ACQUISITION SYSTEM

(SCADA)

A. SCADA MASTER CONTROL STATION

1.0 SCOPE OF WORK

1.1 PROJECT OBJECTIVE AND BRIEF DESCRIPTION OF THE PROJECT

The application of Smart Solutions under Smart City Mission of Udaipur City shall enable the city to use modern technology, information and data to improve infrastructure and services. As part of the smart solutions the following utility/ infrastructure facilities shall be provided with SCADA Automation and Control System:

(A) **Water Supply Facilities** - Improvement of water supply facilities by carrying out complete automation of the Water intake, Water Treatment Plant and Water Distribution Network by installing SCADA compatible equipment and providing Instrumentation and Local SCADA Control Station at Intake and WTP and linking these with SCADA Master Control Station at Command and Control Centre of the project.

(B) **Sewerage System** - Automation of Sewerage by providing SCADA system for existing sewerage pumping stations for rehabilitation and up-gradation of the system. It is also intended to provide a system for monitoring of manholes with level and flow sensors from a centralized location.

(C) **Power Distribution System** - The smart city solution also covers replacement of existing overhead HT & LT power distribution system with underground HT, LT cabling and providing Intelligent Ring Main Units for ring circuits. The existing pole mounted distribution sub stations shall be replaced with compact packaged substations. It is proposed to provide Feeder Remote Terminal Units for monitoring and control of the power distribution system from SCADA Master Control Station.

SCADA facilities for Power Distribution System shall cover the following:

a) Providing Feeder Remote Terminal Units (RTUs) for the entire underground power distribution network.
b) Providing SCADA & Automation facilities for the 33/11 KV substation at Bailghar and its distribution feeders.
c) Providing SCADA & Automation facilities for two Compact Substations at DudhTalai RWPS.

(D) **Underground Ducting -** The proposed underground utility system of the Area Based Development project envisages Dewatering Submersible Pumps. In case flooding takes place in the underground duct, these pumps shall be used to lift water and discharge it into the road side drain. It is proposed to provide Ultrasonic Water Level Indicators for level measurement, generate alarm, control pump operation and transmit the information to the SCADA Master Station at Command and Control Centre.

The overall goal of the SCADA system is to monitor and control the above facilities from SCADA Master Control Station located at the Command & Control Centre of the project. To achieve this, the SCADA system must support the Operator's ability at the SCADA Control Centre to perform all the related functions by providing complete and accurate information to the operator, thus enabling the Employer to monitor and control all the facilities and network in an efficient and reliable manner.

The intent of this specification is to specify the requirements of SCADA Master Control Station in order to achieve the above objectives of the project.

The SCADA Master Control Station is proposed to be located at the Command & Control Centre of the Smart City project. However, all servers shall be at the Collector office premises, Udaipur

1.2 The principal items of work for Instrumentation, Automation & Control system include the following:

f) Supervisory Control & Data Acquisition System (SCADA) Control Centre at Command & Control Centre of the project.
g) Instrumentation, SCADA Local Controlled PLC stations for water supply facilities.
h) Instrumentation, PLC stations for sewerage pumping stations of Sewerage System
i) Underground manhole monitoring system
j) Feeder Remote Terminal Units (FRTU) of the underground power distribution network.
k) Remote Terminal Units of 33/11 KV substation.
l) Remote Terminal Units for Two Compact Substations at DudhTalai RWPS.
m) Communication Interfacing Equipment for linking with SCADA Master Control Station(s).
n) All software, including SCADA Software, Application Software, PLC Software and Programming Tools, etc.
o) All associated cable data highway.
p) Interface Communication network.
q) Integration, Testing and Commissioning of the complete system.

The integrated Instrumentation and Control System shall ensure the supervision and coordination of all controls and monitoring functions of the project facilities and allow their coordinated operation controlled from the centralized location.

This specification document describes the mains functions, features and general technical requirements of the various sub systems. The Contractor shall implement these functions and features, both tailored to the process and equipment to be controlled and monitored

1.3 SCOPE

a) The scope of work includes all hardware and software required to ensure satisfactory operation of the Instrumentation and SCADA system and facilities. The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's factories before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and erection and commissioning at site of various equipment and materials including associated hardware and software as specified in this document.
b) It is not the intent to specify completely herein, all details of design, construction and installation of the equipment and accessories. This implies that the Contractor shall supply all equipment, devices, apparatus, appliances, material and labor not herein specifically mentioned or included, but which may be found necessary to comply with the requirements implied in this specification. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be performed by the Contractor.
c) The Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this

specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability.

d) Whether called for specifically or not, all accessories and work required for the completion of the work are deemed to be considered as part of the Contractor's scope, unless and until mentioned very clearly in exclusions.

e) The Employer may not initially procure all capabilities specified in this document. Regardless of the system configuration purchased, the system shall be capable of all functions specified herein.

f) Should the Contractor elect to subcontract manufacturing, installation, or any other work defined herein, it shall remain the Contractor's responsibility to manage the complete project scope.

g) It is the Employer's intent that the Contractor use as much standard hardware and software as possible; however, all of the functional requirements of this Specification must be satisfied. The use of the Contractor's standard hardware and software may cause the Contractor to conclude that there is a need for additional items not specifically mentioned in this Specification. The Contractor shall supply all such items and provide a complete system design that meets all of the Employer's functional requirements defined in this Specification.

h) In the event of system configuration of the system given in Specification undergoes changes during detailed engineering, the prices of the system shall also be adjusted based on the unit prices as indicated in the price schedules for spares.

1.4 SCOPE OF WORK FOR SCADA MASTER CONTROL STATION

1.4.1 The scope of work shall be a comprehensive functional system complete in every respect, including but not be limited to following:

a) Three sets of SCADA Servers (Redundant)
b) Three sets of CFE/FEP Servers (Redundant)
c) Three Sets of Network Management Servers (Redundant)
d) Three Sets of Fixed Engineering Station with all necessary accessories
e) Two Portable Engineering stations, each with dockable arrangements, printer, all necessary accessories and software,
f) Three sets of Application Server (Historical Server)
g) Three sets of Personal Computers/Lap Top
h) Time, day and Date Digital Display
i) Duplicated LAN system, including Cables, Data Switch
j) Three Operator Workstations each with two sets of TFT monitors and all necessary accessories and software
k) Three Dot Matrix Printers
l) Three Inkjet Printers
m) Three Laser Printers
n) One projection type Large Screen Display with display controller acting as a video mimic (with three separate sections)
o) Routers/gateway with necessary firewall functionality for control and remote operation of all the facilities comprising Power Supply, Water Supply, Sewerage and Underground Ducting as per the project requirement with all necessary interfaces, accessories and equipment,

p) One set of router / gateway with necessary firewall functionality for communication between Master Station and facilities field stations.
q) One set of router/gateway with necessary firewall functionality for Data transmission to State/ Regional Master Control Centre through available communication media.
r) Data Acquisition System (DAS) / Data logger system comprising of two (2) nos. of high-capacity Network Attached Storage systems (one main + one hot standby)
s) One Training simulator, with all necessary accessories, software along with at least 5 user licenses, implemented on separate workstations and connected to the Central Control Room Network
t) GPS Receivers (6)
u) UPS Power Supplies for the entire station,
v) Operating desks for Engineering Stations, Data Storage system and Operator Workstations,
w) Four chairs with bending mechanism, sitting height adjustment and ergonomic adjustment with desk etc.

1.4.2 Software

Supply of all necessary software, their license for use, and source codes for the process software that are specific for this project,

1.4.3 Interface Cabling

All interface cabling between Contractor-supplied equipment within control room, SCADA and communication rooms are included in the scope of Contractor. All communication connections including cables, modems and splitters from SCADA to communication equipment are also included in the scope. The Contractor shall also supply and install all power cables from AC and DC Distribution Boards to SCADA equipment.

1.4.4 INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted by the contractor that all the Local Control Stations, PLC Stations, Feeder Remote Terminal Units, Remote Terminal Units, Field Devices, Instruments, etc. of the utilities and services comprising Water Supply, Sewerage System, Power Distribution System, Utility Ducting shall be ultimately connected through dedicated communication links (Fibre Optics Cables/ Radio Communication/GSM Communication Network) to the SCADA Master Control Station to be installed at the Command & Control Centre of the Smart City Project. These communication links are excluded from the scope of this contract. However, the integration of SCADA/Automation & Control System and Complete Instrumentation of the Water Supply, Sewerage System, Power Distribution System, Utility Ducting with the SCADA Master Control Station is included in the scope of work of the Contractor under this contract. The contractor's scope also includes all necessary co-ordination with the other contractors in order to provide a fully functional SCADA system.

TECHNICAL SPECIFICATION

2.0 TECHNICAL CONDITIONS

2.1 GENERAL

This document, in conjunction with the detailed technical specifications, describes the technical requirements, functions and features of the SCADA System and its associated equipment and cables. The Contractor shall implement these functions and features, both tailored to the requirements specified in this document and that actually required at various locations.

2.2 BASIC SYSTEM REQUIREMENTS

All equipment supplied shall conform to the following requirements:

a) The system shall be consistent with modern practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.
b) All equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the Project Specifications, Drawings, Engineering data, instructions, and recommendations of the equipment manufacturer as approved by the Employer.
c) The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production.
d) All equipment shall be of modern compact design incorporating the latest developments in proven technology.
e) All equipment, cabinets and devices shall be heavy-duty type, designed for continuous industrial service.
f) All equipment provided shall be of modular construction and shall be capable of field expansion.
g) The field mounted equipment and system components shall be designed for installation in dusty, humid conditions prevailing at sites. The contractor shall refer to the environmental conditions as applicable to this project.
h) The equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the Employer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance therewith.
i) The equipment shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability.
j) All Electronic/ Digital equipment shall have high electro-magnetic and radio frequency interference immunity and shall not be affected by portable radio transmitters operated in the vicinity of the equipment. Any limitations shall be stated by the Supplier.
k) All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.
l) Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 of IS 13947 Part I. All instruments of submersible type shall be protected to IP-68 of IS-13947 Part I.
m) All the computers, peripherals, software, actuators, sensors, measuring instruments and other hardware shall be of latest state of the art at the time of supply. The SCADA system design shall be such that in case of a fault in any single equipment others are not affected

and system continues to function effectively.

2.3 STORAGE AND OPERATING CONDITIONS

The contractor shall refer to the environmental conditions as applicable to this project. All equipment supplied shall be capable of withstanding any combination of environmental conditions in which it can be stored or operated without mechanical or electrical damage or degradation of performance as specified therein.

2.4 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS

The contractor shall note that all electrical works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, in regard to the rules and regulations that may be applicable.

2.5 CONTRACTOR TO INFORM HIMSELF FULLY

The contractor should ensure that he has examined the General Conditions, Specifications and Schedules as brought out in other sections of the bid document and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied. The Employer shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Employer.

Site Locations - The Contractor may undertake site visits and obtain all required information before the submission of the bid.

2.6 STANDARDS

a) It shall be the responsibility of the Contractor to ensure that the quality and specification of the equipment, materials and works are as per the latest revisions of national and international standards like IEC, IEEE, NEMA, etc. In case the requirements specified in this document are less stringent than the national or international norms or standards. the equipment covered by this specification shall, unless otherwise stated, be designed, manufactured and tested in accordance with the latest revisions of relevant Standards and shall conform to the regulations of local statutory authorities.

b) The standards referred to in the Specification shall govern in all cases wherever such references are made. In case of any conflict between such standards and this specification, the Contractor shall immediately point out the same to the Employer and seek clarification on the same.

c) Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately.

2.7 CONTRACTOR'S REQUIREMENT

a) The Contractor should be in possession of a valid License from the Chief Electrical Inspector, Govt. of Rajasthan before commencement of the Work, failing which the Work Site will not be handed over to the Contractor.

b) The Chief Electrical Inspector, Govt. of Rajasthan or his Authorized Representatives may inspect the sites during construction. It is the responsibility of the Contractor to obtain pre-requisite formal clearance/ approval from the said Inspectorate prior to commissioning of any equipment. The Employer may assist the Contractor in obtaining the aforementioned approvals

c) The furnishing of data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

d) All data submitted by the Contractor after review by the Employer shall be part of the contract document.

2.8 DATA SHEETS

All data sheets appended to bidding documents must be completely filled in by the bidder. The bidder shall specifically note that incomplete information or non supply of important information may result in rejection of his bid.

2.9 DRAWINGS AND DATA TO BE SUBMITTED WITH BID

The Contractor shall submit along with the bid all drawings and other data as stated in different sections of this document. These drawings and documents shall include sufficient details to demonstrate fully that all supplies and works included in the Contractor's scope shall conform to the provision and intent of these specifications. These drawings and documents shall provide sufficient details of the equipment, its description, type, size, Bill of Quantities, etc. Information related to arrangement, overall dimensions clearance etc. required for assembling and dismantling and furnishing the space requirements of all apparatus shall also be included to enable the Employer to determine the design and layout of the installation and to decide the compatibility of the bid.

2.10 DRAWINGS AND DOCUMENTS FOR APPROVAL

In addition to those stipulated in clause regarding drawings in General Conditions of Contract (GCC)/ Special Conditions of Contract (SCC), the following also shall apply in respect of Contractor Drawings:

a) All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

b) Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

c) The drawings submitted by the Contractor shall be reviewed by the Employer as far as practicable and shall be modified by the Contractor if any modifications and / or corrections are required by the Employer. However, it shall be the responsibility of the Contractor to review the proposed changes and point out any possible problems such as conflict with

existing standards, etc. before incorporating the changes so that no technical problems may arise. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good line shall not alter the contract completion date.

d) The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.
e) The drawings submitted for approval to the Employer shall be in requisite number of copies.

All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the drawings shall be at the Contractor's risk. In case the contractor finds the necessity of making any changes in the design, such changes will again be subject to approval by the Employer.

The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:

a) The Contractor has completed the part of the Works covered by the subject document.
b) The Works appear to comply with requirements of Specifications

In no case the approval by the Employer of any document does imply compliance with neither all technical requirements nor the absence of errors in such documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

The following is a broad list of the documents and drawings that are to be submitted by the contractor:

a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.
b) System Configuration Diagram
c) General Layout of Control Centre Equipment
d) General layout of each field station
e) Function design document of all equipment.
f) Hardware description documents.
g) Data Sheets of each equipment, cables & auxiliary equipment
h) Bill of Quantities
i) I/O list
j) General arrangement drawing with full dimensions of panels
k) Instrumentation Drawings
l) PLC/ HMI programming standards
m) Software details
n) Test procedures
o) Cable Layout and details.
p) Cable and wiring schedule, as applicable.
q) Wiring diagram, where applicable.
r) Communication cables details.
s) Earthing layout and details.
t) General layout of each station
u) Training documentation/ Training Manuals
v) Operation & Maintenance Manuals
w) Any other drawing/ document that is considered necessary for Employer’s information/ approval.

All Designs / Drawings / Calculations/ Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts / works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

The drawings submitted for approval to the Employer shall be in requisite number of quantities. One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections". The contractor shall there upon furnish the Employer additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.

2.11 FINAL DRAWINGS AND DOCUMENTS

The successful Contractor shall be required to provide following drawings and documents in requisite type and quantities as per the requirements of the project:

a) All approved drawings of equipment and works related to a particular CSS F.

b) Instruction manuals of all equipment that shall generally consist of:

- Operation Manuals,
- Maintenance Manuals,
- Spare Parts Bulletins.
- Copies of routine test reports of relevant equipment.
- Final Guaranteed and Other technical particulars of relevant equipment.

a) Copies of type tests and routine test reports of relevant equipment.

b) Final Guaranteed and Other technical particulars of relevant equipment.

c) Final list of software applications and configuration details.

d) Backup copies of all system configurations (F)

2.12 AS BUILT DRAWINGS

After the completion of the onsite erection work, the contractor shall furnish requisite copies of the ‘As Built’ drawings showing changes, if made, during erection for reference and record of the Employer. These Drawings also shall be stored on CD and supplied to Employer.

2.13 DESIGN CO-ORDINATION

Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best co-ordinate performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

2.14 DESIGN IMPROVEMENTS

The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

2.15 QUALITY ASSURANCE AND QUALITY CONTROL

2.15.1 Quality Assurance

To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub Contractor's premises or at site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract.

The Contractor shall submit to the Employer a quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of supply. The Quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required. The approved quality plan shall form the basis for inspection and acceptance of the equipment. The Employer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval.

2.15.2 Quality Assurance Plan for Site Installation & Commissioning

The contractor shall submit the Quality Assurance Plan giving details of stage inspection during installation, pre-commissioning and commissioning tests and customer witness / hold points. The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. Test Procedure shall be specified giving for each test item (kind of test) a description, test method / standards, used instruments, sample/routine test, etc. The tests will also include the applicable standards and acceptance criteria.

2.15.3 Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employers inspection of equipment/material.

The Employer or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractors/his vendors Quality Management and Control Activities.

2.16 EMPLOYER'S SUPERVISION

To eliminate delays and avoid disputes and litigation it is agreed between the parties to the Contract that all matters and questions shall be resolved in accordance with the provisions of this document.

The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the Employer, pursuant to the contract, will include but not be limited to the following:

(a) Interpretation of all the terms and conditions of these Documents and Specifications.

(b) Review and interpretation of all the Contractors drawings, engineering data etc.

(c) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.

(d) Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.

(e) Issue certificate of acceptance and/or progressive payment and final payment certificate.

(f) Review and suggest modification and improvement in completion schedules from time to time, and

(g) Supervise the Quality Assurance Program implementation at all stages of the works.

2.17 SPARE PARTS

a) Recommended Spare Parts

The Contractor shall furnish an item wise list of recommended spare parts and quantity for three years satisfactory operation of the equipment with unit price of each part in a separate Schedule. Prices of these spare parts shall not be taken in to account in comparing Price Bid. Also, they will submit an undertaking to supply all spare parts for a minimum period of 10 (ten) years as and when any request is made before them on a chargeable basis.

a) Mandatory Spare Parts

The contractor shall also quote for the mandatory spares list. Prices of these spare parts shall be taken into account in comparing price Bid.

2.18 CONSTRUCTION TOOLS & TACKLES

Contractor shall provide all required tools for enabling connection with any other intelligent device of which protocol, message structure, message organisation are known so the F can scan the device and transmit the data to the control centre when polled. The Contractor shall submit a list of all such materials to the Employer before the commencement of work at site. These tools and tackles shall not be removed from the site without the written permission of the Employer

2.19 VENDOR LIST

Reference shall be made to the **Preferred Vendors list**. Equipment to be supplied and not covered or which does not conform to this list due to the manufacturer's own standards shall be submitted for approval.

2.20 REFERENCE STANDARDS

The system and equipment shall be designed, built, tested and installed to the latest revisions of the applicable standards. The table below gives a non – exhaustive list of the reference standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed Engineering for the purpose:

IEC 60051	Recommendations for indicating electrical measuring instruments and their accessories
IEC 60065	Safety rules for electrical devices connected to a network procedures
IEC 60255	Electrical relays
IEC 60326	Printed boards
IEC 60332	Flame retarding characteristics of electric cable
IEC 60337	Auxiliary devices for control
IEC 60478	Level of spurious signal emission Stabilized power supplies, DC output
IEC 60529	Degree of protection
IEC 60617	Symbols on Electrical drawings
IEC 60625	Interface system for programmable measuring instruments (byte serial, byte parallel)
IEC 60721	Conditions of environment
IEC 60793 Part 1	Optical Fibre- Measurement and test procedures
IEC 60793 Part 2	Product specifications
IEC 60847	Local area network characteristics
IEC 60870	Telecontrol equipment and systems
IEC 60950	Equipment safety
IEC 61000	Electromagnetic compatibility for industrial process - measurement and control equipment
IEC 61131	Programmable Controllers
IEC 61158	Digital data communications for measurement and control - Fieldbus for use in industrial control systems
ISA S5.1	Instrumentation Symbols and Identification
ISO 2110	25-point connector
ISO 8802	Information process systems
ISO 9000	Quality management and quality assurance standards
ISO 9001	Quality systems: Model for quality assurance in design / development, production, installation and services
ISO 9002	Quality systems: Model for quality assurance in production and installation
ISO 9003	Quality systems: Model for quality assurance in field inspection and tests
ISO 11064	Ergonomic Design of Control centres
IEEE 1046	Application guide for distributed digital control and monitoring for power stations
ANSI / IEEE C37.1.1987	Definition, specification and analysis of systems used for supervisory control, data acquisition and automatic control.

2.21 ENGINEERING DATA

The furnishing of Engineering data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

All Engineering data submitted by the Contractor after review by the Employer shall be part of the contract document.

2.22 GURANTEED TECHNICAL PARTICULARS

The contractor shall fill up the Questionnaire for Guaranteed Technical Particulars of each item of the equipment as given in Annexure - I and submit the same with the technical bid. The Contractor shall also furnish any other information which their opinion is needed to give full description and details to judge the item(s) offered.

2.23 COMMISSIONING SPARES

It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.

2.24 TRAINING

It is important that Employer's personnel be adequately trained in the installation, operation, maintenance and expansion procedures and techniques of the supplied system. The training program shall be comprehensive and provide for interdisciplinary training on hardware and software. The training program shall be conducted in English.

The details of the training, training duration and the number of personnel shall be mutually discussed with the successful contractor.

2.24.1 Training Material

Comprehensive training manuals shall be provided for all training courses and the course material presented in a format that is easy to comprehend. The manuals shall serve as teaching aids during presentation of the training classes and as reference material after the training has been completed. It is not recommended that the Contractor use system technical documentation solely as the training manuals since system documentation is generally not written in an instructional format. Portions of system documentation may be incorporated into training manuals provided that the overall manual achieves an instructional format.

2.25 TYPES OF TESTS

The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

a) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to Commencement of commercial production against the order.

The contractor shall indicate his schedule for carrying out these tests.

b) Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

c) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.

d) Tests during Manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.

The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed between the Contractor and the Employer

2.26 TYPE TEST REPORTS

All Bids must be accompanied by the Type Test Certificates of equipment offered. Such type test certificates shall be acceptable only if :

a) Tests are conducted in an independent and well known testing laboratory,
b) Tests are conducted in manufacturer's own laboratory. In this case the laboratory must have ISO 9000 (or its equivalent) series certification; tests have been witnessed by technically qualified representatives of earlier clients or purchaser.
c) Test reports to be acceptable must be related directly to the equipment offered. Test reports for higher class of equipment are acceptable with commitment to perform the type tests free of any charge on the particular equipment(s) after the award of contract.
d) Type tests certificates are required for following equipment:
    i) Main processor unit
    ii) I/O modules
    iii) Power supply modules and charges
    iv) Communication interface modules
    v) HMI (Human-Machine Interface) display unit
    vi) Modems
    vii) Converters
    viii) Any other equipment considered necessary by the employer
    ix) Type Test Reports older than five (5) years on the date of Technical bid opening shall not be accepted.

2.27 SYSTEM TESTING

a) As part of the requirement of this specification section, it is the responsibility of the contractor to provide a complete operational control system. It is required that the contractor demonstrate that the system was fully tested during development and installation and is a functioning, integrated, and reliable system. The testing requirements require a comprehensive and progressive series of contractor conducted tests, contractor certifications, and Employer's witnessed tests.
b) The basic testing requirements shall require the contractor to provide tests for all equipment and software. All software and all equipment including mechanical, electrical, and all other equipment shall be tested both individually and together as an integrated system.
c) All tests shall be conducted in accordance with the relevant standards / Employer approved test procedures, forms and check lists submitted by the contractor.

d) As a minimum, the testing shall include the following:

- Factory Acceptance Testing (FAT)
- Site Acceptance Testing (SAT)

Items of equipment/ system not covered by standards shall be tested in accordance with the details and programme agreed between the Employer and contractor.

2.28 FACTORY ACCEPTANCE TESTING (FAT)

A Factory Acceptance Test and verification for all deliverable equipment, software, and associated documentation shall be performed prior to shipment of subsystems or major components. The equipment factory tests shall be performed to verify that the equipment is manufactured and assembled correctly, is operating as designed, and is in compliance with the contractual requirements for the deliverables. The factory test shall be performed to verify that the software and hardware will meet the functional and performance requirements of the complete project. The system shall (as a minimum) be tested for the following:

a) Operation requirements

b) Operating characteristics

c) Response times

d) Software functions

e) Deficiencies - Various process signals shall be simulated for carrying out above system tests.

The contractor shall submit a FAT test procedure to the Employer for approval prior to start of the FAT.

2.29 SITE ACCEPTANCE TESTING (SAT)

a) A Site Acceptance Test of the functions, software, and performance shall be conducted individually at each site (or facility process) after all elements have been installed and the I/O Point Checkout has been completed at each site.
b) The system Site Acceptance Tests shall be performed to verify complete operation of the system, requiring a repeat of much of the factory acceptance tests but with the equipment installed at the permanent sites, and shall include additional tests required to verify field-installed equipment which was not available at the factory.

2.30 INSPECTION & INSPECTION CERTIFICATE

a) The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have, at all reasonable times, access to the premises and works of the Contractor and their sub-contractor(s)/sub-vendors and shall have the right, at the reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.

b) The inspection of all equipment/systems required to be supplied to complete the works shall be done as detailed in this Specification. Only defect free and sound material meeting the technical requirements of this Specification and in accordance with a high standard of Engineering would be acceptable to the Employer's Representative.
c) For meeting these requirements of inspection, testing shall be carried out by the Contractor and certificates submitted to the Employer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Valid calibration certificates for test instruments shall be produced for the Employer's consent in

advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of equipment/ system not covered by standards shall be tested in accordance with the details and program agreed between the Employer and Contractor.

d) If during or after testing any item of the equipment/ systems fails to achieve its intended duty of otherwise prove defective it shall be modified or altered as necessary, retested and re-inspected as required by the Employer.
e) No equipment/system is to be delivered to Site without the above described inspection having been carried out or officially waived in writing by the Employer's Representative.
f) The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the Contract.

2.31 GUARANTEES

The contractor shall be responsible to replace, free of cost with no transportation and insurance expenses to the Employer up to the destination of materials specified in schedule of dispatch, the whole or any part of the material which under normal and proper use and maintenance proves defective in material or workmanship for a period of three years for all SCADA Hardware equipment/ devices and five years for all SCADA Software from the date of "Employer's Taking Over". This shall override the warranty periods as defined in the General Contract Conditions. Such replacement shall be effected by the Contractor within a reasonable time actually required to do so. Contractor's liability upon the expiration of the period mentioned above shall terminate.

2.32 NAMES of Reputed Vendors for SCADA SYSTEM

Siemens, ABB, Allen Bradley/Rockwell Automation, Areva T & D, Schneider Electric, Yokogawa, Emerson, Motorola

2.33 KEY PERFORMANCE INDICATORS

The Contractor shall demonstrate its ability to reach the performance requirements. Performance tests shall be carried out during the Factory Acceptance Tests.

1. Computer Start Up

Total time for the start-up of a computer, including automatic program load, initialization and database updating, shall not exceed five minutes for critical functions (SCADA, front-ends servers). Automatic restart following a power outage shall also not exceed five minutes.

2. Complete SCADA functionality shall be available within a further five minutes following a start-up or automatic restart of the last computer in the minimum set of computers required to be running to support this functionality. Updates from field devices may extend beyond this time but the full update of the System with data from the field shall not exceed a further five minutes. Thus, a complete restart of the System, including full update from the field, shall not exceed 15 minutes.

3. SCADA System must have System availability of 99.9 %.

The Contractor shall submit with the bid, the System availability values for each major equipment/ component as well as the complete system, supported by availability calculations.

1.34 Penalty

A minimum Penalty @ INR 10,000.00 will be levied per incidence of non-compliance with point 1, 2 and @ INR 50,000.00 for compliance with point 3, respectively, which may be increased by the Procuring Entity.

3.0 SYSTEM FUNCTIONAL REQUIREMENTS

3.1 GENERAL SYSTEM REQUIREMENTS

This section describes the functions to be performed by the SCADA system. Each function is presented in sufficient detail to provide the Contractor with as much in sight as possible into both the initial and future requirements of the SCADA system. All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

3.2 PRIMARY FUNCTION

The SCADA system shall be the operational interface to support the monitoring, operation and control and instrumentation of all utilities and services comprising:

a) **Water Supply Facilities** - Water Intake, Reservoirs, Pumping Stations, Water Treatment Plant and Water Distribution Network
b) **Sewerage System** – Pumping Stations, Underground Manhole Monitoring System,
c) **Power Distribution System** - Ring Main Units, Compact packaged substations of the underground power distribution network, 33/11 KV substation at Bailghar and compact substations at Dudh Talai water facilities.
d) **Underground Ducting** - Dewatering Submersible Pumps of the underground duct.

The overall goal of the system is to monitor and control the above facilities from SCADA Master Control Station located at the Command & Control Centre of the project. To achieve this, the SCADA system must support the Operator's ability at the SCADA Control Centre to perform all the related functions by providing complete and accurate information to the operator, thus enabling the Employer to monitor and control all the facilities and network in an efficient and reliable manner

The system shall enable the process information to be made available to the operator in the form of various displays and print outs, either automatically or on demand by the operator.

3.3 SCADA FUNCTIONS

The SCADA system shall perform the following basic functions :

a) Acquire through field stations the operational parameters data from field devices, compile, accurately analyze, calculate and record the operational information and save the processed data in the data base.
b) Perform real time process control, timer initiated events, process initiated events, system and program initiated events, operator initiated events, concurrent tasking and time tagging of inputs.
c) Assist operating personnel by alarm from abnormal operating conditions and equipment failure.
d) Acquire all measurements and perform all necessary calculations based on automatic and manual operator data inputs.

e) Accumulate and store equipment running times, transactions and changes in process, store information for use in preventive maintenance, management and inventory control.
f) Store and retrieve all O&M information, manuals (both data and graphics).
g) Compile and prepare daily, weekly, monthly reports.
h) Manage and schedule all O & M functions

3.4 DESIGN REQUIREMENTS

The system shall be governed by the following design requirements:

a) The SCADA system and its associated components shall be selected taking the following requirements into consideration:
   - Reliability of components and subsystems,
   - Scalability of the system for future extensions,
   - Backward compatibility and Interoperability with other subsystems,
   - Availability of spares,
   - Ease of maintenance,
   - Service availability and adaptability for future technology developments.

b) All equipment shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory, and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.

3.5 USER INTERFACE CONTROL

The Operator should have control of all major equipment and process set points from the control centre or RTU/PLC panel. The Operator shall be able to respond to process changes or alarms by operating the field devices 9as applicable) and changing the set points. Control shall be executed primarily through the HMI at the control centre and as a backup, through the RTU/PLC.

3.6 REAL-TIME CONTROL AND ADJUSTMENT

All control and adjustment actions shall be validated by operator before execution.

From the Operator Workstations in control room, the operator shall have the possibility to perform real-time control and adjustment for all equipment of the scheme. To this end, it shall be possible for him to:

- enter Assigned Set Points,
- give direct orders,
- modify operating parameters

Assigned Set Points shall be for immediate action, and shall be maintained until a new assigned Set Point is received.

Orders shall be on/off controls entered by the operator to the SCADA system for processing. Orders shall be for example:

- start-up and stop of the units,
- change of control mode,
- change of priority for start-up or stop a unit, or for a component,,

- opening and closing of controlled devices.

3.7 CONTROL MODES

Control Modes shall be coordinated through the use of LOCAL-OFF-REMOTE switches. These are:

- LOCAL: Changes to process equipment are initiated from the L-O-R switch. A pump in the LOCAL position shall be controlled through the local START and STOP buttons. A valve may be opened and closed through the local OPEN and CLOSE buttons or a switch.
- OFF: All local commands to the device are disabled. A running pump will stop when switched to the OFF position.
- REMOTE: Changes to process equipment are initiated from the RTU/PLC,or Control Centre. The REMOTE control mode shall have two states, changeable between Control centre HMI and RTU/PLC panel
- SCADA-MANUAL: Changes to process equipment are initiated by an Operator.
- SCADA-AUTO: Changes to process equipment are initiated by a control strategy available in the RTU/PLC logic.

3.8 CONTROL TIME-OUT

Maintenance mode procedures shall be provided to modify the time-out periods associated with the various types of device control. These time-out periods shall include a maximum time for the operator to select a control action after device selection in which case the entire control request shall be cancelled. The maximum anticipated time to receive a device status change after a control sequence has been completed shall be adjustable under the system maintenance mode.

3.9 CONTROL DISPLAYS

The operator shall normally monitor the various utilities **network** through these displays. The displays shall be organized in the form of network overview display, group displays, individual process display and object displays. The master station will issue **commands to field devices through** respective RTU/PLC's. The change of status will be sent back to the MCC (and also to SCC concerned, if required) and also to verify that the command has been executed.

It shall be possible to display mimic diagrams which represent respective utilities **network in color graphic form of various systems/sub-systems.**

The control display shall have the following features :

a) Updation of dynamic information every second.
b) Display (in red color) of the alarm variables.
c) It shall be possible to change the color and flash the variables and equipment symbols to indicate alarm or change of status.
d) It shall be possible to include bar charts and trends as part of mimic diagrams or construct pictures containing only bar charts and trends.
e) The minimum number of mimic diagrams to be displayed shall be 100.

3.10 INTEGRITY SCANNING

It shall be possible to report the values of all scanned points (regardless of whether they changed) in the following cases:

a) On start-up of the system

b) After loss of communication with the RTU/RTU/PLCs/RTU/PLCs

c) Periodically while running

d) On operator's request

3.11 ERROR & MISMATCH MESSAGES

It shall be possible to manage different messages indicating a mismatch between the SCADA server and the Front End server database or an error in communication path.

3.12 DATA GROUPING

The data at any RTU/PLC shall be grouped according to its priority and use from operating point of view and SCADA system polling frequency assigned to each group of data. The polling frequencies shall be individually adjustable from one poll each 15 seconds to one poll each hour in increments of 10 seconds, for different groups of RTU/RTU/PLC/RTU/PLC data. Grouping of data and polling frequency shall be user configurable.

a) Report by exception data shall be updated maximum within 30 sec.

b) Backup update reports are user configurable once every 30 minutes onwards.

3.13 DATA PRIORITIES

The retrieval of status data shall have a higher priority than the retrieval of analogue data and check back execute indications of just completed control actions shall have the highest priority.

3.14 DATA VALIDITY

The SCADA system shall include an analogue data validity analysis function. This validity analysis shall be for out of range or unreasonable values. Maintenance warnings shall be displayed and logged to indicate these events.

3.15 DEVICE CONTROL SELECTION

Control requests initiated by the operator shall pass control point identification and the required control action to the control software. The software shall validate the control point and the control action required according to system status, any defined interlocks and assigned responsibilities. Error messages shall be displayed if the operation is not permitted.

3.16 AUDUBLE AND VISUAL WARNING SIGNALS

The SCADA system shall be equipped with the following audible warning signals. Intensity of sound level shall be adjustable.

1. ALARM - This takes the form of a continuous 2900 Hz tone pulsing 2.5Hz. This shall operate for any field plant initiated alarm. This warning signal shall be capable of being silenced by operation of a `silence' button on the local keyboards.
2. ALERT - This shall take the form of 2900 Hz tone, 3 seconds duration. This shall operate for any condition similar to Alarms, but derived and initiated from system software. This warning signal shall automatically re-set after 30 seconds by the software, provided a further Alert condition has not been detected.
3. It shall be capable of being silenced by operation of a `Silence' button on the local keyboards.

4. CHANGE OF STATE – This shall take the form of a single beat gong. It shall operate on detection of any plant change of state not classified as alarm.

This `Silence' action shall be separate from an Alarm or Change of State `Acceptance' action and a `Silence' action shall not effect an `Acceptance', but an `Acceptance' shall effect a `Silence' action if not previously activated.

`Silence' actions shall not be event logged but `Acceptance' actions shall be event logged.

3.17 SELECT-CHECK-BACK-EXECUTE - START/STOP/OPEN/CLOSE CONTROL

All control functions shall utilize the select-check-back-execute control sequence and digital output sub-system of field stations shall recognize two commands associated with device control.

After point selection and control action have been verified, the software shall initiate a select-check back-execute control sequence with the selected field station RTU/PLC/ Local Control and independent of the initiating select procedure. When the control action is initiated, the software shall set a flag showing that a device change-of-state is expected. Failure to receive a status change within a predefined period shall show a faulty control action and initiate an alarm at the Master Control Station.

3.18 SUPERVISORY CONTROL FUNCTIONS

Supervisory control functions shall comprise of multi-step interactive procedures to avoid accidental operation of plant equipment.

These interactive procedures to be supported shall include:

- Start/stop/close/open control
- Set-point control
- Sequential control

The SCADA system shall lead the operator through all of the correct steps necessary to successfully operate the selected device and minimize the chances of incorrect operation.

3.19 START/ STOP/ OPEN/ CLOSE CONTROL

This control function shall be used to control multiple state devices in the pipeline system and the SCADA system. All these control functions shall utilize the select-check back-execute control sequence and Digital output sub-system of RTU/PLCs shall recognize two commands associated with device control.

The following procedure shall be used for open/close control of a device;

- **Execute the control function:** The color of the symbol for the designated device on the display shall be changed to indicate the selected status. The selected device and the required control function shall be identified on a dialogue line together with the control blocked or inhibit status of the device. This step shall be time-supervised. If the control request in the next step of the dialogue is not made within a defined; period, then the device selection shall be automatically cancelled and the dialogue line cleared/. In this sequence, the permissive shall be checked.
- **Execute the open or close function:** If the control request is valid, the device status shall be changed and the dialogue line cleared. If the control request is not valid, the selection of the device shall be cancelled and an error message displayed in the operator message line.

The control request shall be processed as an event.

3.20 SET POINT CONTROL

The set point control function shall be used to provide a set point for analogue control equipment.

The set point changes shall require two execution steps. The first step is to change the analogue output to desired value. The second step is to generate a Gate signal (Digital output to the analogue control equipment to indicate that a new set point value is to be read.

3.21 Sequence of Event Data (SOE)

The system shall provide accurate time value of status changes for devices monitored by suitable RTU/PLCs. A Sequence of Event RTU/PLC shall have its clock periodically synchronized.

Sequence of Events Reporting

SOE status point changes shall be reported and processed. The host SCADA shall be responsible for processing the SOE log data received from the front end servers and for displaying the information to the operators.

3.22 LOCAL CONTROL

All equipment shall be provided with the means to operate the equipment locally in LOCAL mode. Such control may be at the device itself or at the associated MCC or local panel. Local control shall be fully independent of RTU/PLC control, and is activated by placing the Local-Off-Remote switch in the LOCAL position. Indication of the position of all LOR switches shall be provided, as required on the SCADA System HMI.

3.23 TIME SYNCHRINIZATION

The primary workstation of the SCADA system shall be the `Master Clock' for the overall system Date and Time Facility. The RTUs/PLCs should be synchronized with the master clock. Whenever the SCADA workstation Date and Time is set or reset, an automatic synchronizing signal shall be transmitted by telemetry to all RTUs/PLCs. Any RTU/PLC subject to a `Telemetry Failure' shall automatically be sent a synchronization signal on restoration of telemetry.

Should there be a discrepancy between time at a remote station and the time received from SCADA workstation by telemetered synchronization signal, then the remote station local intelligence shall automatically re-set and synchronize local time with SCADA workstation time within resolution of 10 msec. This synchronization shall be recorded as an EVENT and printed out.

All the nodes on the dual LAN, at the Master Stations shall be synchronized with the master clock every one minute permitting maximum 10 msec time difference.

3.24 REPORT BY EXCEPTION

All analog and status data shall be requested on a report by exception basis to avoid unnecessary processing when the analog dead band has not been exceeded or no status changes have occurred. This is to avoid unnecessary data communication between RTU/PLC & SCADA system.

Depending on the database downloaded to the individual RTU/PLC, a RTU/PLC will scan the I/O points and determine the points to be reported when polled by SCADA system.

The analog dead band, de bounce time, backup report update time, etc. shall be configurable as part of database definition. Further, it shall be possible to use integrating dead band for analog data to ensure that even small changes shall cause transfer after some time when the value is stable.

Accumulator readings shall also be reported by exception as soon as they are presented by the RTU/PLC.

For analogue data, it shall be possible to report a new value if the difference between this value and the previous one exceeds a specific dead-band to be specified by the operator.

3.25 DATA INTEGRITY

The data request software shall generate RTU/PLC data integrity poll to enable the checking of the integrity of stored data in the database at the RTU/PLC. The integrity poll shall be initiated periodically according to polling tables and after major system status changes, RTU/PLC power failure and major computer system events including restart and fail-over. Also a point defined for backup update reporting shall update its value/status, if it did not report by exception in a given time (user definable).

3.26 DATA REQUESTS

The SCADA system shall be capable of periodically polling all RTU/PLC's with data request messages according to polling information in polling tables. It shall be possible to define a RTU/PLCs more than once in a polling table per data channel.

RTU/PLC's shall be polled by the SCADA system for status change, analog data change and totaliser value update within every 30 seconds including envisaged future expansion.

Polling tables and polling sequences shall be subject to approval by the Purchaser.

3.27 SCADA SYSTEM POLL MODES

In addition to the general polling requirements outlined above, several other poll modes (user configurable) shall be implemented. They are:

- Demand poll – to enable an update of a group of points at the operator's request.
- Fast poll – to enable update data from a particular station on an immediate basis.
- To enable fast updates of data required for various applications.
- Poll inhibit – to enable individual points or complete RTU/RTU/PLCs/RTU/PLC's to be disabled from the polling function.

3.28 TELEMETRY FAIL AND POLL INHIBIT

Reliable detection and correction mechanism shall be implemented for data communication. If valid data is not received from a RTU/PLC in response to a poll request, the software shall attempt retransmission of data from that RTU/PLC. The number of re-polls to be attempted shall be adjustable by the maintenance procedures for each poll period.

If a RTU/PLC or its communication channel fails, all individual points at that RTU/PLC shall be marked in the database to indicate telemetry failure but only one alarm shall be generated. The

database shall retain the last good value or status for every point affected until the telemetry returns to normal. Return to normal alarm shall be generated and RTU/PLC shall update (when polled) with respect to all points.

The operator shall have the capability to inhibit any point from scanning or an entire RTU/PLC from poll processing. In this situation the operator may substitute values for the data for points with defective telemetry or which have been inhibited for poll processing (substitution shall be prohibited for a point in poll and judged to be valid). Alternately a point taken in manual mode shall automatically put the point off scan. The substitute value shall be retained until poll processing on that point or station is restored.

The status of the data values (valid, subject to telemetry failure, substituted etc.) shall be indicated in the database and shown on MMI displays and printed logs.

3.29 COMMUNICATION PROTOCOL & POLLING MECHANISM

SCADA system shall poll each RTU/PLC according to a fixed protocol on that channel on continuous basis. The protocol should support dynamic allocation of telemetry cycles for effective utilization of channel bandwidth. It is envisaged that report by exception technique with specific data polling in the background is offered. The protocol shall permit alarms and analog values that have changed since last poll to be time tagged as per RTU/PLC time and sent to SCADA system ensuring minimum time between successive RTU/PLC polls and orderly transmission of all data during time of peak activities. The protocol structure shall support up to minimum 256 RTU/PLCs dispersed on multiple communication channels. Messages to and from the field shall be transmitted over these channels concurrently and asynchronously.

The protocol should support all standard data types. Command sent from SCADA system to RTU/PLC shall interrupt the upcoming stream of data on the completion of current data frame to ensure good system, response. An all stations call shall allow the SCADA system to address all the RTU/PLCs simultaneously.

The protocol shall ensure that all the messages are received without communication errors and that the messages are transmitted in correct priority basis and integrity of transmitted data is ensured through multiple error detecting codes to prevent errors and use error correcting codes in conjunction with acknowledge/negative acknowledge handshake on each transmission. Error detection codes shall be BCH or CRC message checksum codes.

3.30 MODIFICATION OF OPERATING PARAMETERS

All operating parameters shall be modifiable by the operator. Operating parameters shall be for example:

- Thresholds for alarm generation,
- Thresholds for start-up and stop the units,
- Category of events for Event Log functions,
- Operating constraints.

3.31 MODIFICATION OF SOFTWARE

It shall be possible to add, delete or modify any variable in the database on-line with no disturbance in the real-time running of the programs.

For all the equipment, such modifications shall be made on the Engineer Station. Access to this function shall be protected by an easy-to-use password. It shall be possible to display all the attributes of a variable on the screen at the same time, and modifying them shall require no knowledge of their physical location or their computer code.

Each modification event shall be dated and memorized in a file.

3.32 ACCESS CONTROL

The system shall have extensive features to prevent unauthorised access to the system. The security system shall be in addition to that provided in the operating system and access to the functionality of the system shall be subject to additional security checks. Pass Word security shall be provided for access to the system and its applications. It shall permit only authorized users to access a system through the consoles. Users shall log in by entering a user ID and a PW. Each PW shall be validated against the corresponding user information in the database. A successful log-on operation shall the user access. Each log-on and log-off shall be reported as an event. The event message shall indicate the date and time the procedure was executed, the name of the console and identification of the user.

A secure method shall be provided for the designated authority to establish and change pass words and user identifications. System pass words shall be stored in encrypted form. Users shall have the ability to change their own pass words.. it shall be done via a single entry sequence and propagated to all authorized system applications and processors.

The log-in status of the user shall be unaffected by any failure recovery procedure of the SCADA system.

3.33 INSTRUMENTATION FAULTS

The SCADA system shall have the ability to identify and react to malfunctioning instrumentation. Input signals that are abnormal or out of range should be alarmed. In addition, the SCADA system must be capable of modifying or inhibiting control when signals assume abnormal or out of range values. Equipment control must be automatically placed in a fail safe mode upon instrument failure.

3.34 EQUIPMENT FAULT MONITORING

Any time field equipment fails to respond to commands, changes status without Operator or strategy intervention or switches states, the SCADA system shall notify Operations via an alarm.

3.35 INFORMATION FOR MAINTENANCE AND STATISTICS

In addition to the functions described in the document, the SCADA system shall perform all necessary functions for a convenient operation and maintenance of the water supply facilities, and needed for statistics. The contractor shall provide the complete details of these functions at the detailing stage.

3.36 SYSTEM DIAGNOSTICS TEST FACILITIES

The SCADA system shall have self-diagnostic functions running on-line and able to detect any failure of hardware or software. Comprehensive test facilities and self diagnostic routines shall be provided to facilitate full functional testing of all subsystem including the modules for

workstations, RTU/PLCs, etc. Comprehensive diagnostics and the test facility for each sub-system shall be an integral part of the SCADA system.

3.37 ERROR DETECTION

Error detection facilities shall be provided at SCADA system for detection and rejection of corrupted or lost telemetry signals. This facility should have equivalent to IEC TC57 or detecting errors.

In the event of failure of an interrogation request/reply cycle the SCADA system shall automatically try again and retransmit. It shall be possible to assign numbers of retries which will be limited to a maximum of 5 retries and shall be system configurable.

3.38 FUNCTIONS AT THE FIELD LEVEL

The states, positions, failures of all the elements monitored from the RTU/PLC level shall be acquired individually by the RTU/PLC and transmitted to the SCADA Control Centre.

The local control level shall include the following equipment:

a) Remote Terminal Unit/Programmable Controller (RTU/PLC), as per specification requirement.
b) Input/ Output Modules
c) Interposing and other relays
d) Terminal boards
e) Measurement devices
f) Maintenance devices

Among the information processed by the RTU/PLC, some items shall generate alarms and shall be parameterized in the database as "major alarms", "normal alarms", or "minor alarms". On the appearance of an alarm datum, the field station :

- Shall generate the alarm and store the event in memory,
- Shall transmit the alarm to the Control Centre for logging functions,
- Alarm processing function on the Human-Machine-Interface,

3.39 INTEGRATION SUPPORT

SCADA system shall support integration of multiple vendor RTU/PLCs, based on latest technology and widely used IEC protocols and the system shall be able to communicate with multi-vendor RTU/PLCs and dependency on the supplier proprietary firmware etc. shall be eliminated.

3.40 DATA COMMUNICATION WITH OTHER CONTROL CENTRES

Provision shall be made to adopt the SCADA system for future remote monitoring from a Remote Control Centre. The highest control level shall be the Operator Workstations in the Central Control Room, From the Operator Workstations, the operator shall have the possibility to perform in real-time, controls and adjustments for all the equipment of the system.

It shall be possible to perform data exchanges with other control centres using ICCP / TASE 2 protocol. Whatever the type of control centre, it shall be possible to exchange at all important data.

4.0 DISTRIBUTED OPEN SYSTEM REQUIREMENTS

The SCADA Master Station configuration shall be based on a distributed computing environment with open system architecture.

The system architecture shall be open internally and externally to hardware or application software additions, whether supplied by the original supplier of the SCADA or obtained from third party vendors, both for capacity expansion and for upgrading functionality, without affecting existing SCADA components or operation.

The system architecture shall be open to accommodate hardware or application software additions, whether they are supplied by the original supplier or obtained from third party Vendors.

The operating system, support software, and applications, as well as APIs that provide standardized interfacing between System software and application software, shall be completely documented.

The following distributed and open-system design concepts shall be used:

a) *The system configuration shall be based on Open Systems Standards in which the software is totally transparent, and any hardware can be replaced/upgraded/ expended with a functionally similar device and not necessarily manufactured by the original Vendor.*

b) The system must be built as independently as possible from the operating systems and hardware in order to enable the later evolutions.

c) The system shall be designed to provide the highest possible level of hardware and software independence through the use of standard products, standard toolkits, and application modularity.

d) The Supplier shall prove that the critical functions can operate with different hardware platforms and operating systems. Supplier shall also prove that the software corresponding to the critical functions have been able to follow the past operating systems and hardware evolutions.

e) Where required, all processing units of the system shall be interconnected using industry standard Local Area Networks (LANs). The LANs shall support the exchange of data from various system components that include: servers, user consoles, communications processors, terminals, gateways, etc.

All internal communications among the SCADA Servers and all external communications between the SCADA and other computer systems shall be based on widely accepted and published international or industry standards which are appropriate and relevant to the open systems concept or should have a field proven acceptance among utilities. This applies to the operating system, database management system, and display management system, as well as to the Application Programming Interfaces (API) providing standardized interfacing between System Software and Application Software.

5.0 SYSTEM ARCHITECTURE

The SCADA System configuration drawing enclosed with this document gives an indicative requirement of the SCADA System. However the development, design and architecture of the SCADA system having all necessary features and programmed software for all applications in accordance with the Technical Specifications is the responsibility of the Contractor. The Contractor is free to propose suitable modifications, if considered necessary in order to meet the

functional requirements of the system. The proposed configuration of the equipment shall be described fully, emphasizing the availability and security provided. .

6.0 CONTROL CENTRE EQUIPMENT

The overall SCADA control shall be affected from the Master Control Station which is proposed to be located at the Command & Control Centre of the Smart City project. However, all servers shall be supplied and installed by others at the Collector office premises, Udaipur

The equipment at the control centre shall comprise of the following:

a) Three sets of SCADA Servers (Redundant)
b) Three sets of CFE/FEP Servers (Redundant)
c) Three Sets of Network Management Servers (Redundant)
d) Three Sets of Fixed Engineering Station with all necessary accessories
e) Two Portable Engineering stations, each with dockable arrangements, printer, all necessary accessories and software,
f) Three sets of Application Server (Historical Server)
g) Three sets of Personal Computers/Lap Top
h) Time, day and Date Digital Display
i) Duplicated LAN system, including Cables, Data Switch
j) Three Operator Workstations each with two sets of TFT monitors and all necessary accessories and software
k) Three Dot Matrix Printers
l) Three Inkjet Printers
m) Three Laser Printers
n) One projection type Large Screen Display with display controller acting as a video mimic (with three separate sections)
o) Routers/gateway with necessary firewall functionality for control and remote operation of all the facilities comprising Power Supply, Water Supply, Sewerage and Underground Ducting as per the project requirement with all necessary interfaces, accessories and equipment,
p) One set of router / gateway with necessary firewall functionality for communication between Master Station and facilities field stations.
q) One set of router/gateway with necessary firewall functionality for Data transmission to State/ Regional Master Control Centre through available communication media.
r) Data Acquisition System (DAS) / Data logger system comprising of two (2) nos. of high-capacity Network Attached Storage systems (one main + one hot standby)
s) One Training simulator, with all necessary accessories, software along with at least 5 user licenses, implemented on separate workstations and connected to the Central Control Room Network
t) GPS Receivers (6)
u) UPS Power Supplies for the entire station,
v) Operating desks for Engineering Stations, Data Storage system and Operator Workstations,
w) Four chairs with bending mechanism, sitting height adjustment and ergonomic adjustment with desk etc.

7.0 SCADA SYSTEM SIZE AND EXPANDABILITY

Modular system design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, process I/O cards, drive control modules, hand/auto stations, push button stations, peripherals like TFT/Keyboards, printers etc. The system shall have the capability to add any new control loops groups/subgroups, in control system while the existing system is fully operational.

It is of utmost importance that the SCADA System design provides sufficient capacity and expandability to handle not only the present but also expected future requirements.

System design, insofar capacity and expandability are concerned, shall meet the following general requirements:

a) It shall be designed, delivered and commissioned with sufficient capacity for performing specified requirements, inclusive of` all applicable optional software packages.
b) Hardware and software shall be of modular design. Neither system functions nor hardware structure shall be subject to major disruptions when expanding, adding to, modifying or testing the hardware or software.
c) Further, clear defined procedures shall be given for the improved performance of all modifications related to the addition of one or more supplementary equipment s or the modification of software to reflect changes in the electrical network.

SCADA system database size shall be configured to store and process as a minimum the number of I/O points as indicated in this document and 50% spare points. The system delivered shall have the capability to be expanded by 100% of required number of configured points. Expansion shall be accomplished in the future by software reconfiguration without addition of new software.

8.0 RESPONSE TIMES

The protocol and polling mechanism is required to meet response times as under:

a) Time for transferring all changes of states of equipment and alarms of the entire pipeline not exceeding 15 seconds.
b) Time for updating display of any single selected analog variable or digital measurement not exceeding 2 seconds.
c) Time for execution of any controls not exceeding 2 second from the time operator initiation has taken place.
d) Time for complete data basis polling/processing/update/logging for the entire pipeline network not exceeding 30 seconds.
e) The communication frame structure definition shall be as per IEC/ISO 870-5-101.
f) Updation time of any graphic display on color VDU not to exceed 2 sec.
g) Updation of trend displays shall not exceed 5 sec.
h) Mimic data shall be updated once in every 30 sec.

9.0 COMMUNICATION INTERFACE WITH FIELD STATIONS

SCADA Master Control Station shall communicate with field stations/devices over redundant communication links. Communication between all field stations/devices and control centre shall be by Fibre Optics/GSM Communication System. Only one link shall be used at a time with one link active and the other in standby mode. Switchover and failover of the communication links shall be controlled by the Control Centre and RTU/PLC shall respond on the communication links it last received a message on.

The hardware and software of the SCADA system shall be suited to the telecommunication equipment. Router / gateway with necessary firewall functionality, interfaces and accessories shall be provided for communication/data transfer between field stations/devices and Control Centre.

The Employer will supply communication channels between the RTUs/PLCs and the SCADA system master station. The communication channels will consist of either of the communication media comprising optical fibre cable links, GSM/GPRS/Radio/Microwave with modems and splitters as applicable. Use of dedicated or party-line communication channels shall be supported. The data transfer rate for each RTU/PLC shall be configurable in the SCADA software.

The redundant communication ports shall be provided at CFEs (one for primary and one for secondary channel) for communicating with the field devices capable of working at high speed data rate.

10.0 INTEROPERABILITY

The complete design of the SCADA system shall be based on interoperability of equipment from different manufacturers and the Contractor shall be responsible for overall functional integration of the system. The control system shall be implemented on open standards. The Contractor shall be responsible for establishing necessary SCADA communications/data exchange interfaces for interoperability with other SCADA Systems. The SCADA Systems for all the facilities, viz. Power Supply, Water Supply and Sewerage system shall be remotely controllable from the Command and Control Centre of the project so as to ensure a cascade/tandem operation in an optimized manner. The Contractor shall ensure compatibility with the SCADA systems of all the facilities in this regard.

It shall be the responsibility of the Contractor to verify and solve all interoperability issues of various components / equipment connected to the network. The Contractor shall perform a type conformance test to validate the implementation of the communication protocols.

11.0 REDUNDANCY

The SCADA system shall have both physical and functional or operational redundancies. At least the following physical redundancies shall be ensured in the design of the control and monitoring system:

a) Operator station redundancy shall be ensured by mirror images of process data on both the operator workstations
b) All Controllers and their power supply distribution cards used in the system equipment shall be redundant
c) Event and Alarm printers shall be configured to take over the duties of each other in the event of failure of any one of them
d) The database storage system shall be redundant and implemented through two Network attached storage devices
e) Networking redundancy shall be implemented by using redundancy of servers, routers and switches in dual star with dual homed mesh redundancy
f) Redundancy of communication media shall be through redundant optical fibre cables/ GSM

12.0 RELIABILITY AND AVAILABILITY

It is a fundamental requirement that the System (and individual items of equipment within it) shall be designed for high reliability and that hardware and standard existing software used within the System should have been proven in service.

The System availability shall be at least 99.9%, assuming an 8-hour Mean Time To Repair (MTTR) for equipment at the Control Centre. This figure includes availability of all critical functions that is the SCADA functions and all the Real-time Network Analysis applications.

The following facilities are the minimum that shall be available with this probability:

a) *All real time functions for which the system is designed, including:*
b) Data acquisition, without the compilation of historical data records
c) Supervisory controls

13.0 POWER SUPPLIES FOR OPERATOR WORKSTATION

Contractor shall ensure that in no case, any single fault (either electronics or cable) in the power feeding / distribution scheme for all the equipment / components / devices of the SCADA system shall lead to non availability of more than one display device or printer.

14.0 PORTABLE ENGINEERING STATION (MOVABLE)

The contractor shall also include in the offer (as an optional item) the supply of a portable engineering workstation with all features and accessories to maintain, reprogram, check the status and test the RTUs/PLC's, loaded with all software & system configuration settings similar to fixed engineering station necessary for the purpose.

15.0 SCADA SOFTWARE

15.1 The specification provides for the design, manufacture, testing at works, supply, delivery, installation, testing and inspection, completion, setting to work and maintenance during the maintenance period of the SCADA Master station real-time software necessary to meet the processing and performance requirements detailed in this document and the field devices comprising of Remote Terminal Units and Programmable Logic Controllers of the various utilities.

The software shall be supplied with all software packages and displays fully developed, installed and tested including the configuration of the database, logs, tables and displays.

15.2 SOFTWARE REQUIREMENTS

a) The Contractor shall supply licensed version of all software with development and deployment tools used. While passing on the rights of using the software/software tools to the Employer, the Contractor shall ensure that such rights are inclusive of the use of that software for development purpose. The source codes of project specific application software shall be the property of the Employer.
b) The software shall be modular in structure and facilitate performance of intended functions in an efficient manner. It shall also facilitate changes and extensions of the system. In particular, it shall be possible to modify any module with minimum changes in other modules, and to upgrade peripherals and human-machine units in the future with no extensive rewriting of the software.

c) This software shall be fully developed as a standard product. Programs shall be modular with each module performing a clearly defined task, with user friendly interface and field proven capabilities
d) Complete documentation including program listings in source language for application and customized application software shall be provided. All documentation and computer print-outs shall be in English only.
e) All software shall be implemented according to the Contractor's latest established design and coding standards. Complete and comprehensive documentation shall be provided for all software. Contractor may consider providing windows based software as it is preferred for its user friendliness. Contractor shall provide the configuration software training to USCL Engineers for the purpose of maintenance and configuration modification
f) The prices quoted for software shall include the cost of licensed software required for actual running of the applications, including all supporting software packages, tools, etc. The Contractor must deploy the software as specified in this document and ensure its smooth running as per the requirement of a fully integrated system. The prices quoted shall also include necessary data collection, compilation and entries for testing of the software.
g) The software functions shall broadly fall into the following categories:
    - Supervisory Control & Data Acquisition - SCADA functions, including management of database, data processing, storage and retrieval. The major functions to be provided are described in this specification. The application software offered shall facilitate the secure execution of all these functions.
    - Human Machine Interface (HMI) - The utilities network information shall be presented to the operator via the HMI. The functional requirements of HMI are separately described in this specification document. It is intended that standard software will be implemented, wherever possible.
    - Support & Diagnostics - The diagnostics software shall provide continuous correct operation of all system functions even when essential system components fail. The support software shall include automated backup/restore and archive facilities provided by menu driven utilities.
h) In order to meet the objectives of the SCADA System, the software shall be capable of handing the required number of analogue, digital, pulse type signals and command functions as per the requirements specified in this document. These quantities, in conjunction with **response times** as defined in this specification shall determine the capacity and size of equipment to be provided. All data will be acquired by field stations for processing and subsequent transmission to the Master Station.
i) The design and the computer system shall be such that the specified response and update times can be achieved based upon the ultimate capacity.
j) The operation of the software shall be demonstrated, and subsequently documented, to the satisfaction of the Employer before the system is accepted.
k) The contractor shall upgrade all such developed software during the warranty period and all operation and maintenance period as per contractual provisions. The Contractor shall provide to the Employer the latest versions of all such software, including source codes while finally handing over the system. All procurements shall be invariably in the name of the Employer.
l) The Contractor shall ensure that all reasonable security measures have been incorporated in the systems and all software, upon commissioning is free of viruses and has all default accounts and passwords removed or disabled.
m) In addition to all the test procedures specified in this document, all other aspects of the procured/developed software, e.g, security, modularity, functionality, reliability, maintainability, etc. shall be tested.

n) The Contractor shall also provide all storage media, operating manuals at every site for ensuring minimum downtime of the system.

15.3 SOFTWARE STRUCTURE

The software shall be field proven in similar type of application. As a minimum requirement, this shall cover the following:

- System and Database configuration
- Generation of current raw & processed telemetered database.
- Generation of historic data for trending and archival.
- Alarm handling, including storage, display and printout
- Generation, storage, presentation of mimic diagrams with dynamic information presentation on screen.
- Display management for alarm alerts, mimic diagrams analog and digital values, trend graphs, bar charts in semi-graphic and high-resolution colour graphic modes.
- Free format report generation, storage and printout.
- Data logging at periodic intervals, on operator request and automatically on occurrence of an event.
- Redundancy, workstation determination, fail-overs and recovery processes
- Database synchronisation with processes

15.4 Real-time Database

The system shall comprise a main and standby real-time database which shall be open. The main and standby real-time databases shall be continuously updated by the processed information from the field stations and that entered by the operator. In the event of failure of the main database server, the system shall initiate a general check to ensure the validity of the information contained within the standby database.

15.5 Database Management

Engineering facilities shall be provided for database and graphic display creation and modification facilities at the operator stations.

The facilities provided shall be such as to allow, as a minimum, the following:

a) Creation of new databases.
b) Adding data associated with field stations.
c) Installing new or modified VDU diagrams and lists.
d) Installing new or modified log formats.

Full details of display generation and data modification procedures shall be provided, and in particular this shall provide details as to how additional data points and additional field stations shall be incorporated in the database.

15.6 Graphic Display construction

Basic drawing facilities shall be provided allowing graphic displays to be constructed from a library of standard symbols. Details of how the library symbols and graphic displays are constructed shall be provided.

15.7 Data Processing

In the event of detection of a data transmission error or failure, indications and alarms from the previous successful scan shall continue to be displayed on the monitor. Facilities shall be incorporated to indicate automatically to the operators that the relevant data has not been updated. On all overviews an indication/warning shall be provided indicating abnormal state.

15.8 Display Updating

Information on the current displays shall be updated immediately after processing and entry into the database. Periodic refreshing of the display data shall ensure the latest data is displayed.

15.9 General Check

The master control station shall periodically initiate a positive update of all status indications in order to ensure the validity of information contained in the database.

15.10 SYSTEM SOFTWARE (Operating System)

The operating system shall be latest Windows based network operating system available at the time of supply. All Servers shall also be based on latest Enterprise edition of windows based Server operating system available at the time of supply. The system shall be designed to allocate resources to tasks in a real-time environment. Resources may be memory, input/output peripherals or communication. The Real Time Operating System supplied shall be proven for similar applications and shall be able to support all the equipment/peripherals.

It shall have the following minimum features :

- Multiprogramming, Multithreading and Multitasking facility including background and foreground operations in real time mode.
- Real time capabilities
- Dynamic Memory allocation
- System Security Features
- Real time Programming and Processing
- Support disk mirroring
- Line and Page editors, library management
- Real time database management
- RDBMS/SQL database management
- Dual LAN support
- OSI/TCP/IP network connectivity support
- Graphic support packages

15.11 CUSTOMIZED APPLICATION SOFTWARE

The application software provided by the Contractor shall have been tested and commissioned successfully in the field. The Contractor shall supply a copy of the source program, listings and descriptions, and shall clearly indicate any restrictions, special conditions. It is essential that the Employer shall be able to modify all the application software himself without calling the Contractor.

The customized application software components shall include at least the data base, the graphic picture editor, report compiler and human machine interface. Widely proven software products shall be used to meet the system requirements. All operating parameters shall be modifiable by the operator and necessary interfaces /mimic views/ forms shall be provided for assigning set points with respect various parameters, assigning unit priorities, and giving direct orders/commands to the system.

All software shall be licensed with no licensing restrictions on the number of connected HMI clients. The software shall be licensed to provide an unlimited number of graphic displays and to allow an unlimited number of operator logins available.

15.12 SOFTWARE MAINTENANCE AND DEVELOPMENT TOOLS

A set of software shall be provided to enable maintenance of application software and development of new software in software development mode.

All hardware and software facilities shall be provided to allow creation, modification and debugging of programs in all languages that are supplied.

The following shall thus be possible:

a) Program and data editing

b) Program compiling and assembling

c) Linking

d) Loading, executing and debugging program.

In addition, Supplier shall demonstrate that the software being delivered has been developed and is maintained using software management tools. These tools shall at least support the following features:

a) Software components identification

b) Version management

c) Concurrent development capability

d) Easy to use build procedures.

The software management tools shall be delivered along with the system, so that the Employer can use it for his own software development and also System upgrades**.**

All those tools must be also available on engineers PCs running Microsoft Windows™ for ease of use by programmers and engineers.

15.13 SYSTEM MONITORING AND DIAGNOSTIC PROGRAMS

Performance and utilization monitoring software package shall be provided to verify system loading, performance and utilization of all computers. It shall provide on-line statistics on computer systems utilization on a user selectable cyclical basis or at one time upon request.

15.14 DIAGNOSTIC PROGRAMS

Diagnostic programs shall be provided for all the servers, workstations, and LAN/WAN. They shall be simple to operate including interactive procedures and print out or hard copy facilities.

ANNEXURE - *5F - 1

GUARANTEED TECHNICAL PARTICULARS (GTP)

FOR

REMOTE TERMINAL UNIT

All information in this document shall be filled by the Bidder and supported with manufacturer's printed Technical literature. If any information given in the document is found to differ at the final handing over, the contractor shall be held responsible for it and cost of improvement to meet the indicated specifications shall be recovered from any payments due to the contractor.

Sl. No.	DESCRIPTION	PARTICULARS	REMARKS
1.0	**GENERAL**		
a)	Tender's name & address		
b)	Name & Address of Manufacturer's factory i. Postal Address ii. E-mail Address iii. Fax/Tel.		
c)	Make and Country of manufacture		
d)	Does the equipment conform to ISO 9001 or 9002/BSEN ISO 9001 or 9002 series quality standards (Yes/No)		
e)	Reference to accompanying catalogues, technical literature & drawings provided with the Tender		
f)	Tenderer's proposal no. & date		
g)	Name and address of tenderers' representative from whom technical clarification can be obtained.		
2.0	**TECHNICAL**		
2.1	**Remote Terminal Unit**		
a)	Make & Type		
b)	Processor module microprocessor type		
c)	Details of Communication Ports available		
c)	IEC60870-5 101 Slave protocol supplied		
d)	IEC60870-5 103 Master protocol supplied		
e)	MODBUS RTU Master protocol supplied		

f)	DNP3.0 Master protocol supplied		
g)	RTU Programming Software and accessories supplied		
h)	Ability to add software applications to processor module (i.e. automation logic, protocols)		
i)	Ability to expand RTU by adding hardware		
j)	Ability to configure and download configuration remotely		
k)	Hardware/software - Number of analog inputs (max)		
l)	Hardware/software - Number of digital inputs (max)		
m)	Hardware/software - Number of counter inputs (max)		
n)	Hardware/software - Number of digital control outputs (max)		
2.2	**DC Analog Input**		
a)	Input voltage/current range		
b)	Input impedance		
c)	Number of inputs per card supplied		
d)	**A/D converter:**		
i)	Method		
ii)	Output code (bits plus sign bit)		
iii)	Offset adjustment range		
iv)	Ability to reconfigure by software		
v)	Quantising error		
vi)	Maximum input offset		
vii)	Maximum scale factor error		
viii)	Maximum relative accuracy		
ix)	Max conversion time		
2.3	**AC Analog Input**		
a)	Nominal and max input voltage range		
b)	Nominal and max Input current range		
c)	Input impedance		
d)	Number of inputs per card supplied (PT/CT)		

e)	**A/D converter:**		
i)	Output code (bits plus sign bit)		
ii)	Offset adjustment range		
iii)	Ability to reconfigure by software		
iv)	Self-calibration		
v)	Sampling rate		
vi)	Accuracy in % of nominal		
vii)	List of derivative points calculated		
viii)	List of energy counters calculated		
2.4	**Digital Input Module**		
a)	Maximum Number		
b)	Number of Inputs per card supplied		
c)	Contact wetting options and voltages		
d)	Scan Rate		
e)	Types Accepted		
f)	Ability to reconfigure by software		
g)	Software configurable options – debounce filtering, chattering filtering, single/double status, invert status, COS/SOE generation		
e)	SOE time stamp resolution		
f)	Input Impedance		
g)	Time delay		
h)	Isolation withstand		
i)	Transient Voltage Withstand		
2. 5	**Digital Output Module**		
a)	Maximum Number		
b)	Number of Outputs per card supplied		
c)	Trip/Close, Raise/Lower, Latching modes		
d)	Self-checking failure protection		
e)	Local/Remote switch per module		

f)	Interposing relays required		
h)	Relay contact rating (V and I)		
i)	Relay contact configuration		
j)	Ability to reconfigure by software		
2.6	**RTU & Battery Charger**		
a)	Manufacturer		
b)	Type of rectifier		
c)	Nominal input voltage and range		
d)	Power factor		
e)	DC output of rectifiers/rating		
f)	Type of DC voltage control		
g)	Range of float DC voltage control		
h)	Rectifier transformer input rating		
i)	Charging time to bring batteries back to peak voltage		
2.7	**RTU Batteries**		
a)	Manufacturer		
b)	Type		
c)	Voltage		
d)	Electrolyte Material		
e)	Capacity at 24 hour rate		
f)	Number of cells		
g)	Voltages per cell		
h)	Size of cell (h x w x d)		
i)	Weight of cell, including electrolyte		
j)	Internal resistance of batteries when charged		
k)	Float voltage range		
l)	Boost voltage range		
m)	Overcurrent protection		
2.8	**Modem**		

a)	CCITT standards		
b)	Communication data rates		
c)	Modulation		
d)	Power input required (V and W)		
e)	RS232 to RS485 converter for IEDs interfaces		
f)	Protocols supplied (all standard requests, commands, replies and objects supported)		
g)	IEC60870-5-101		
h)	IEC60870-5-103		
i)	MODBUS		
i)	DNP3		
j)	Master simulation		
k)	Slave simulation		
l)	Monitoring of communication exchanges		
m)	Single/continuous transmission of messages		
n)	Modem compatible with FRTU modem supplied		
2.9	System Expandability Provision Details		
2.10	Fault Diagnostics Provisions		
2.11	System Spare Capacity provision details		

ANNEXURE – 5F - 2

GUARANTEED TECHNICAL PARTICULARS (GTP)

FOR

PROGRAMMABLE LOGIC CONTROLLER (PLC)

All information in this document shall be filled by the Bidder and supported with manufacturer's printed Technical literature. If any information given in the document is found to differ at the final handing over, the contractor shall be held responsible for it and cost of improvement to meet the indicated specifications shall be recovered from any payments due to the contractor.

Sl. No.	DESCRIPTION	PARTICULARS	REMARKS
1.0	**GENERAL**		
a)	Tender's name & address		
b)	Name & Address of Manufacturer's factory iii. Postal Address iv. E-mail Address iii. Fax/Tel.		
c)	Make and Country of manufacture		
d)	Does the equipment conform to ISO 9001 or 9002/BSEN ISO 9001 or 9002 series quality standards (Yes/No)		
e)	Reference to accompanying catalogues, technical literature & drawings provided with the Tender		
f)	Tenderer's proposal no. & date		
g)	Name and address of tenderers' representative from whom technical clarification can be obtained.		
2.0	**TECHNICAL**		
2.1	**Programmable Logic Controllers (PLC)**		
a)	Make & Model		
b)	Reference Standards		
c)	Details of CPU module		
d)	Type of Memory and back up		
e)	Memory Size with specific details of spare capacity		

f)	Redundancy Provisions		
g)	Optical Isolation		
h)	PLC Programming Software and accessories supplied		
2.2	**I/ O MODULES**		
a)	Hardware/software - Number of analog inputs (max)		
b)	Hardware/software - Number of digital inputs (max)		
c)	Hardware/software - Number of digital control outputs (max)		
2.2.1	**DC Analog Input**		
a)	Input voltage/current range		
b)	Input impedance		
c)	Number of inputs per card supplied		
d)	**A/D converter:**		
i)	Method		
ii)	Output code (bits plus sign bit)		
iii)	Offset adjustment range		
iv)	Ability to reconfigure by software		
v)	Quantising error		
vi)	Maximum input offset		
vii)	Maximum scale factor error		
viii)	Maximum relative accuracy		
ix)	Max conversion time		
2.2.2	**AC Analog Input**		
a)	Nominal and max input voltage range		
b)	Nominal and max Input current range		
c)	Input impedance		
d)	Number of inputs per card supplied (PT/CT)		
e)	**A/D converter:**		
i)	Output code (bits plus sign bit)		
ii)	Offset adjustment range		

iii)	Ability to reconfigure by software		
iv)	Self-calibration		
v)	Sampling rate		
vi)	Accuracy in % of nominal		
vii)	List of derivative points calculated		
viii)	List of energy counters calculated		
2.2.3	**Digital Input Module**		
a)	Maximum Number		
b)	Number of Inputs per card supplied		
c)	Contact wetting options and voltages		
d)	Scan Rate		
e)	Types Accepted		
f)	Ability to reconfigure by software		
g)	Software configurable options – debounce filtering, chattering filtering, single/double status, invert status, COS/SOE generation		
e)	SOE time stamp resolution		
f)	Input Impedance		
g)	Time delay		
h)	Isolation withstand		
i)	Transient Voltage Withstand		
2.2.4	**Digital Output Module**		
a)	Maximum Number		
b)	Number of Outputs per card supplied		
c)	Trip/Close, Raise/Lower, Latching modes		
d)	Self-checking failure protection		
e)	Local/Remote switch per module		
f)	Interposing relays required		

h)	Relay contact rating (V and I)		
i)	Relay contact configuration		
j)	Ability to reconfigure by software		

ANNEXURE – 5F - 3

GUARANTEED TECHNICAL PARTICULARS (GTP)

FOR

INSTRUMENTATION EQUIPMENT

All information in this document shall be filled by the Bidder and supported with manufacturer's printed Technical literature. If any information given in the document is found to differ at the final handing over, the contractor shall be held responsible for it and cost of improvement to meet the indicated specifications shall be recovered from any payments due to the contractor.

Sl. No.	DESCRIPTION	PARTICULARS	REMARKS
1.0	**GENERAL**		
a)	Tender's name & address		
b)	Name & Address of Manufacturer's factory v. Postal Address vi. E-mail Address iii. Fax/Tel.		
c)	Make and Country of manufacture		
d)	Does the equipment conform to ISO 9001 or 9002/BSEN ISO 9001 or 9002 series quality standards (Yes/No)		
e)	Reference to accompanying catalogues, technical literature & drawings provided with the Tender		
f)	Tenderer's proposal no. & date		
g)	Name and address of tenderers' representative from whom technical clarification can be obtained.		
2.0	**TECHNICAL**		
2.1	**ELECTROMAGNETIC FLOWMETER**		
a)	Make & Model		
b)	Type		
c)	Accuracy		
d)	Linearity error		
e)	Repeatability		
f)	Calibration		
2.1.1	**Flow Detector Head**		
a)	Enclosure rating		

b)	Field excitation		
c)	Metering tube		
d)	Lining material		
e)	Electrode material		
f)	Pressure effect		
g)	Temperature effect		
2.1.2	**Flow Converter**		
a)	Enclosure rating		
b)	Input signal		
c)	**Output signals**		
	(i) current		
	(ii) pulse		
d)	Low flow signal cut off		
e)	Signal averaging time		
f)	Supply voltage effects		
g)	Frequency effects		
h)	Temperature effects		
i)	Power supply		
j)	Diagnostic		
k)	Programming		
l)	Calibration details		
m)	Accessories to be provided		
2.2	**ULTRASONIC WATER LEVEL SENSOR**		
2.2.1	**Transducer**		
a)	Make & Model		
b)	Type of transducer		
c)	Temperature Compensation provisions		
d)	Measuring Range		
e)	Type of mounting		

f)	Temperature Range		
g)	Relative Humidity		
h)	Accessories to be provided		
2.2.2	**Transmitter**		
a)	Make & Model		
b)	Type		
c)	Resolution (including transducer)		
d)	Accuracy (including transducer)		
e)	Range		
f)	Temperature Range		
g)	Output		
h)	Temperature Compensation		
i)	Display		
j)	Diagnostics		
k)	Loss of Signal		
l)	Configuration Protection		
m)	Accessories to be provided		
2.3	**LEVEL SWITCH**		
a)	Make & Model		
b)	Type		
c)	Weather Protection Class		
d)	Type of service		
e)	Type of Mounting		
f)	Flange		
g)	Material of Float		
h)	Repeatability		
i)	Range		
j)	Type of switch		
k)	Power Supply		

l)	Output (No/NC Contacts)		
m)	Contact Rating		
2.4	**PRESSURE SWITCH**		
a)	Make & Model		
b)	Type		
c)	Weather Protection Class		
d)	Accuracy		
e)	Repeatability		
f)	Over Range Protection		
g)	Set Point adjustments		
h)	Output Contacts details		
i)	Switch Assembly details		
j)	Dead band		
k)	Reset		
l)	Wetted Parts		
2.5	**PRESSURE TRANSMITTER**		
a)	Make & Model		
b)	Type		
c)	Accuracy		
d)	Range		
e)	Supply Voltage Effect		
f)	Temperature Effect		
g)	Static Pressure Effect		
h)	Surge Pressure		
i)	Span Adjustment		
j)	Zero Adjustment		
k)	Damping		
2.6	**PRESSURE GAUGE**		
a)	Make & Model		

b)	Type		
c)	Type of service		
d)	Accuracy		
e)	Dial Size		
f)	Type of glass		
g)	Over range protection		
h)	Diaphragm seal requirement and Material		
i)	Wetted parts material		
j)	Type of process connection		
k)	Accessories		
2.7	**pH MEASURING INSTRUMENT**		
a)	Make & Model		
b)	Type		
2.7.1	**pH Analyser**		
a)	Accuracy		
b)	Sensitivity		
c)	System response time		
d)	Measuring range		
2.7.2	**pH Sensor**		
a)	Sample temperature		
b)	Sample conductivity at 20°C		
c)	Operating Pressure		
2.8.	**TURBIDITY METER**		
a)	Make & Model		
b)	Type		
c)	Principle of operation		
d)	Range		
e)	Accuracy		
f)	Resolution		

g)	Response Time		
h)	Ratio (Color Correction)		
i)	Light Source		
j)	Sample Size (Volume)		
k)	Air Purge		
l)	Calibration		
m)	Repeatability		
o)	Outputs		

B. SCADA for Water supply works

1.0 SCOPE OF WORK

1.1 GENERAL DESCRIPTION OF WORK

This Specification covers the general technical requirements for the equipment required for Instrumentation, Automation and Control systems for water supply facilities. The overall goal of the system is to monitor and control the Water supply facilities covering Water Pumping Stations, Water Treatment Plants, Water distribution network, including leakage sensors in the distribution system. The system shall enable the Employer to monitor and control the above and all related services in an efficient and reliable manner. To achieve this, the control system must support the Operator's ability at the Control Centre to perform all the related functions by providing complete and accurate information to the operator.

This document, in conjunction with the detailed technical specifications, describes the main functions and features of the Instrumentation and SCADA system. The Contractor shall implement these functions and features, both tailored to the process and equipment to be controlled.
The principal items of work include:

r) Complete Instrumentation, Automation and SCADA facilities for Water Works.

s) All software, including SCADA Software, Application Software, PLC Software and Programming Tools, etc.

t) All associated cable data highway.

u) Interface Communication network.

v) Integration, Testing and Commissioning of the complete system.

The integrated Instrumentation and Control System shall ensure the supervision and coordination of all controls and monitoring functions of the water facilities of the project and allow their coordinated operation controlled from the centralized location.

This specification document describes the mains functions, features and general technical requirements of the various sub systems. The Contractor shall implement these functions and features, both tailored to the process and equipment to be controlled and monitored.

1.2 SCOPE

g) The scope of supply includes all hardware and software required to ensure satisfactory operation of the SCADA system and facilities. The scope of work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's factories before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and erection and commissioning at site of various equipment and materials including associated hardware and software as specified in this document.

h) It is not the intent to specify completely herein, all details of design, construction and installation of the equipment and accessories. This implies that the Contractor shall supply all equipment, devices, apparatus, appliances, material and labor not herein specifically mentioned or included, but which may be found necessary to comply with the requirements implied in this specification. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be

performed by the Contractor.

i) The Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability.

j) The system shall be consistent with modern practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

k) The equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the Employer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance therewith.

l) Whether specifically called for or not, all accessories and work required for the completion of the work are deemed to be as a part of the bidder's scope, unless and until mentioned very clearly in exclusions.

1.3 SCOPE OF WORK

The scope of work shall be a comprehensive functional system complete in all respects, including but not necessarily limited to the following:

b) **At each Local SCADA Control Centre** – The equipment shall broadly comprise of two SCADA Servers, two Operator workstations, each with two sets of LCD TFT 20 inches monitors, keyboards and pointing devices and all necessary accessories and software, one color laser report printer, alarm and event printer, one color laser hard copy printer, Dual Front End Devices, Historical data base server, One fixed engineering station with all necessary accessories and software, One portable engineering station with all necessary accessories and software, Data logger, data storage system, necessary routers, Interfaces such as LAN switch for data transmission and extending the Central Control Room Network to connect to field stations, WAN router, modems and communication interfaces for interfacing with SCADA Master Control Station, auxiliary equipment including cabling, connectors, tap-off, interfaces, Operating desks for Engineering Stations, four chairs with bending mechanism, sitting height adjustment and ergonomic adjustment with desk, etc.

c) **At the Field Stations** – Redundant Programmable Logic Controllers at each field station with control panels, software and programming tools, Input/Output modules, Interface cabinets, power supply units, communication interfaces, cables, etc.

d) **All instrumentation** complete with instrumentation panels, all instruments comprising flow meters, level sensors, transmitters, pressure sensors, transducers, transmitters, float level switches, pH measuring instrument, turbidity meter, instrumentation control cables, etc. for meeting the functional requirements of the instrumentation system for the water supply facilities. The scope also includes :

- Connection of all instruments and equipment monitoring and control signals at all project sites to the PLC/RTUs, as required.
- All instruments and associated power, control and signal cabling and wiring, as required.

- Calibration of all instruments at each plant site and provide calibration forms as required by this tender document.
- Establish and configure communications amongst field stations and Control Centre. As per the requirement of this document.

1.3.1 A broad list of the equipment proposed to be supplied and installed is furnished below:

i) Local SCADA control station with complete instrumentation, PLC and associated equipment, cables, interface equipment at Doodh Talai Raw Water Pumping Station
ii) Local SCADA Control station with complete instrumentation, PLC and associated equipment, cables, interface equipment at new Machla Magra Water Treatment Plant.
iii) PLCs/RTU control stations, complete with all associated equipment, cables, interface equipment along with battery packs at all pumping stations.
iv) Ultrasonic Level sensors for measuring Pichola lake level
v) Electromagnetic Flow Meters on each Raw Water pumping main coming out of the pumping stations
vi) Pressure Sensors and Pressure Transmitters on delivery pipes of pumping mains/header pipe,
vii) Energy meters on electric feeders to each pump.
viii) Bulk flow meters at the inlet of all DMA's along with RTU
ix) Pressure sensors on DMA inlet and critical points in each DMA along with RTU.
x) Level sensors at all CWRs.
xi) Instrumentation Control Panels, as required.

1.3.2 Software

Supply of all necessary software, their license for use, and source codes for the process software that are specific for this project,

1.3.3 Interface Cabling

All interface cabling between Contractor-supplied equipment & Employer's panels within control room are included in the scope of the Contractor. The Contractor shall also install power cables from AC and DC Distribution Boards to the Control Centre and PLC's at sites, as required.

Any other items not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

1.4 INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted that the dedicated communication links between SCADA Master Control Station at the Command & Control Centre and Water Supply Local Control Stations/ Programmable Logic Controllers (PLCs)/ Remote Terminal Units (RTUs)/ field devices shall be Fibre Optics Cables/ GSM Communication Network/ Radio Communication. These Communication links is the responsibility of the Employer and is therefore excluded from the scope of work of the Contractor. However, the scope of work of the contractor under this contract covers integration of the complete Water Supply Instrumentation, Automation and SCADA system with the SCADA Master Control Station (s). The contractor shall have to co-ordinate with the other contractors in order to provide a fully functional SCADA system.

2.0 GENERAL TECHNICAL SPECIFICATION FOR INSTRUMENTATION & CONTROL SYSTEM

This Specification covers the general technical requirements for the equipment required for Instrumentation, Automation and Control systems for water supply facilities. The overall goal of the system is to monitor and control the Water supply facilities covering Water Pumping Stations, Water Treatment Plants, Water distribution network, including leakage sensors in the distribution

system. The system shall enable the Employer to monitor and control the above and all related services in an efficient and reliable manner. To achieve this, the control system must support the Operator's ability at the Control Centre to perform all the related functions by providing complete and accurate information to the operator.

This document, in conjunction with the detailed technical specifications, describes the main functions and features of the Instrumentation and SCADA system. The Contractor shall implement these functions and features, both tailored to the process and equipment to be controlled.

All equipment supplied shall conform to the following requirements:

a) All equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the Project Specifications, Drawings, Engineering data, instructions, and recommendations of the equipment manufacturer as approved by the Employer.

b) The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. Generally equipment shall be supplied from one composite range of measurement and control equipment as marketed by a reputable manufacturer of international standing.

c) The equipment shall be of modern compact design incorporating the latest developments in proven technology.

d) All equipment, cabinets and devices shall be heavy-duty type, designed for continuous industrial service.

e) All equipment provided shall be of modular construction and shall be capable of field expansion.

f) The field mounted equipment and system components shall be designed for installation in dusty, humid conditions prevailing at sites. The contractor shall refer to the environmental conditions as applicable to this project. .

2.1 STORAGE AND OPERATING CONDITIONS

The contractor shall refer to the environmental conditions as applicable to this project. All equipment supplied shall be capable of withstanding any combination of environmental conditions in which it can be stored or operated without mechanical or electrical damage or degradation of performance as specified therein.

2.2 DISTRIBUTED OPEN SYSTEM REQUIREMENTS

The configuration of the SCADA system shall comprise a distributed computing environment with open system architecture. The system architecture shall be open to accommodate hardware or application software additions, whether they are supplied by the original supplier or obtained from third party Vendors. The operating system, support software, and applications, as well as APIs that provide standardized interfacing between System software and application software, shall be completely documented.

The following distributed and open-system design concepts shall be used:

a) The system configuration shall be based on Open Systems Standards in which the software is totally transparent, and any hardware can be replaced/upgraded/ expended with a functionally similar device and not necessarily manufactured by the original Vendor.

b) The system must be built as independently as possible from the operating systems and hardware in order to enable the later evolutions.

c) The system shall be designed to provide the highest possible level of hardware and software independence through the use of standard products, standard toolkits, and application modularity.

d) The Supplier shall prove that the critical functions can operate with different hardware platforms and operating systems. Supplier shall also prove that the software corresponding to the critical functions have been able to follow the past operating systems and hardware evolutions.

e) Where required, all processing units of the system shall be interconnected using industry standard Local Area Networks (LANs). The LANs shall support the exchange of data from various system components that include: servers, user consoles, communications processors, terminals, gateways, etc.

2.3 SYSTEM REQUIREMENTS

The system shall be governed by the following design requirements:

a) The control and monitoring system and the components shall be selected taking the following requirements into consideration:
- Reliability of components and subsystems,
- Scalability of the system for future extensions,
- Backward compatibility and Interoperability with other subsystems,
- Availability of spares,
- Ease of maintenance,
- Service availability and adaptability for future technology developments.

b) All equipment shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory, and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.

c) The equipment shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability.

d) All Electronic/ Digital equipment shall have high electro-magnetic and radio frequency interference immunity and shall not be affected by portable radio transmitters operated in the vicinity of the equipment. Any limitations shall be stated by the Supplier.

e) All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.

f) Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 of IS 13947 Part I. All instruments of submersible type shall be protected to IP-68 of IS-13947 Part I.

g) All electrical and electronic systems and all associated software systems supplied under this contract shall conform with Year 2000 conformity requirements.

2.4 TECHNICAL REQUIREMENTS FOR INSTRUMENTATION EQUIPMENT

2.4.1 GENERAL REQUIREMENTS

a) All instruments shall be tested in accordance with the requirements of the standard, wherever specified. In cases where no specific standards are mentioned, the supplier shall submit the list of the standards in accordance with which the instruments are proposed to be

manufactured and tested and these shall be subject to the approval of the purchaser in every case.

b) The instrument cases shall be dust proof, water tight, vermin proof and specially constructed to adequately protect the instruments against damages for deterioration due to harsh environmental conditions prevailing at outdoor site conditions.

c) The instruments shall be designed to work at the ambient conditions of temperature, humidity, dust and chlorine contamination that may prevail. The instruments shall be given enough protection against corrosion and all the wetted parts of the instruments shall be non-corrosive.

d) Electronic instruments shall utilize solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.

e) Measurement and control instruments shall be matched to the main plant equipment ratings in all aspects. Instrument ranges, installation codes of practice and precautionary measures for safety of the Plant and the operating and maintaining personnel shall be observed.

f) All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel.

g) The instruments shall be provided with all the auxiliary appliances and any special tools required for their maintenance. MKS (meter-kilogram-seconds) units shall be used for marking the instrument dials. The range shall generally be such that the normal operating values are indicated in the middle third of the scale.

h) Instruments mounted on panels shall be of the semi-flush finish type and shall be back connected. All instruments on instrument panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements.

i) The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 meters above grade platform.

j) Field instrumentation shall be located so as to be easily accessible for maintenance either from grade or platform. Adequate space shall be allowed around instruments for maintenance.

k) All components or items of equipment within the same instrument loop forming a working system shall be compatible with each other.

l) Equipment which performs a similar function shall, as far as possible, be of uniform type and make in order to facilitate maintenance and stocking of spare parts. Corresponding parts shall be interchangeable.

m) The instruments shall be designed to permit maximum inter-changeability of parts and ease of access during inspection and maintenance.

n) Lockable enclosure shall be provided for all the field mounted instruments.

o) Each instrument shall be properly labeled, and shall be identified by appropriate tag numbers, permanent non- perishable nameplates attached to each instrument shall be used for this purpose.

p) The instrument nameplate shall be mounted on the panel front and rear beneath the instrument. A similar label shall be fitted beneath each of the instrument modules mounted in cubicles. These shall be of laminated plastic or transparent plastic back engraved with black writing on a white background.

q) Unless otherwise specified, double compression glands shall be used for glanding the cable in field instruments and instrument control panel.

r) All instruments supplied shall be complete with all the necessary mounting accessories.

2.4.2 BASIC DESIGN REQUIREMENTS

a) All instruments whether for local indication or remote transmission shall be of good quality shall have an accuracy and repeatability appropriate to their duty.

b) The instruments shall be designed for accurate measurements of the quantity or state under all conditions of operations and any error due to change in the ambient temperature, over the entire range of temperatures obtainable at site, shall be kept to a minimum. The contractor shall state the accuracy and repeatability of each instrument offered which shall be certified, when supplied, by means of supporting documentation.

c) The dials, pointers etc. shall be designed to facilitate glare from instrument window and by providing clear, bold, dial markings. The size of dial and length of the scales of indicating instruments shall be subject to the approval of the purchaser in each case.

d) Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 of IS 13947 Part I. All instruments of submersible type shall be protected to IP-68 of IS-13947 Part I. The external finish shall be in according to manufacturer standard but shall be suitable for the environmental conditions. Particular attention shall be paid to possible effects of corrosion, vibration, humidity, and extremes of temperatures.

e) All indicators shall be linear in process units, unless otherwise noted.

f) All transmitters shall be provided with indicators in process units, accurate to two percent or better.

g) All transmitter output signals shall include signal and power source isolation.

h) All electrical instrument coils shall be designed for continuous operation on at least 120 percent of the full rated current and voltage of the instruments. The instrument coil rating shall be coordinated with those of the associated instrument transformers. The VA burden of instrument coils shall be as low as possible, consistent with the best modern design.

i) The construction of instruments shall be mechanically sound and shall ensure permanence in the accuracy. The limits of error for different instruments shall be stated in the bid and their accuracy classification, where otherwise not specified, shall be subject to the approval of the purchaser.

j) The instruments shall be capable of withstanding the following tests viz., effect of shock, vibration, humidity and dielectric tests of 2000 V to ground for one minute in accordance with relevant standards.

k) Maintenance and fault finding on the equipment shall be facilitated by the provision of test points and indicators on the function boards, and by assembly techniques that allow rapid and easy replacement of components or sub-assemblies.

l) All instrument control panels shall be provided with internal lights and utility sockets at 230 V, 50 Hz, Single Phase AC power supply.

m) Unless otherwise stated, overall accuracy of all measurement systems shall be ±1% of measured value, and repeatability shall be ±0.5%.

n) Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% and 80% of the full scale range.

o) The performance of all instruments shall be unaffected for the ±10% variation in supply voltage and ±5% variation in frequency simultaneously.

p) All digital outputs from the instruments shall be volt free. The relay/switch contacts shall be rated for the voltage of the circuit in which they are to be wired.

q) All analogue displays shall be of the digital type with no moving parts utilizing back-lit liquid

crystal diode (LCD)/ LCD technology.

r) Analogue signal transmission shall be by 4-20mA DC signals, unless otherwise specified and comply with IEC 60381-1. Any other analogue signal levels proposed shall be submitted for approval.

2.5 CABLE TERMINATIONS AND WIRING

a) Terminal blocks shall be used for the connection of all external cables. Power supply terminals of all equipment and terminals of equipment contained within fabricated panels or cubicles shall comply with IEC 60947-7-1. It shall be single-level feed-through, screw or screw less type connection, DIN rail-mounted, vibration and corrosion resistant, and modular design suitable for harsh industrial environment.
b) Terminals shall be permanently identified by number or letter, and shall be so positioned as to permit convenient access for wiring. Adjacent rows of terminals shall not be closer than 150 mm. Power supply terminals shall be segregated form signal terminals and shall be shielded to prevent accidental contact.
c) Access to the terminals of instruments shall not expose internal components, require the disassembly of the instruments or removal of the instruments from the installation as a whole.
d) Cable glands shall be provided to allow cable entry to the instrument enclosures without degrading the required degree of protection.
e) Internal panel wiring shall be coloured black for a.c. connections, grey for d.c. connections and green/yellow for earth connections.
f) At least 10% spare terminals shall be provided.

2.6 ACCESSORIES

a) All equipment shall be supplied with the necessary mounting brackets and fixing accessories to suit the method of mounting detailed in the WSD Standard Specification and Particular Specification
b) All cubicles and panels shall be provided with integral door locks together with three sets of keys.
c) All components such as push-buttons, lamps, relays and printed circuit boards shall be clearly identified by the use of labels. Labels shall be of stainless steel or laminated plastic with engraved legends or of clear Perspex with back-filled legends. Danger and warning labels shall have a red background with white lettering. Labels shall be fixed by screws or adhesive in a position adjacent to the items being identified.
d) For all panels and cubicles where condensation may occur, thermostatically controlled heaters shall be fitted.
e) An extension PCB shall be provided to facilitate onsite maintenance and fault finding of plug-in circuit boards

2.7 DOCUMENTATION

The drawings and manuals shall be as detailed in the related technical Specification and Particular Specification. A list of standard documentation is given below:

a) Instrument Data Sheets
b) Loop Diagrams
c) P & ID's
d) Installation Details (Electrical and Mechanical Hook-up Details)
e) Instrument Index Cable Schedule
f) Location Diagram (Plot Plan)
g) Trip and Alarm Schedule

h) Material Schedule

2.8 TESTS FOR INSTRUMENTATION EQUIPMENT

2.8.1 Type Tests

The Bidder shall submit the test certificates for the 'Type Tests' to the Owners/Engineers Representatives for approval. The type tests for the instruments at manufacturers works (Factory Acceptance Tests) shall be as follows:

- 'Burn In' test for electronic components
- Humidity test for electronic instruments
- Weather protection as per IS-13947
- Hysteresis test
- High voltage test
- Short circuit protection test
- Material test

2.8.2 Routine Tests

All instruments shall be subjected to the following routine tests at the manufacturers works (Factory Acceptance Tests) to ensure correct functioning.

A Factory Acceptance Test, which will be witnessed by Owner Engineers. Factory Acceptance Tests shall be conducted according to test plan with detailed test procedures. The test plan and procedures shall be subject to approval by Owner.

2.8.3 Calibration of instruments

All the instruments shall be calibrated for accuracies as per applicable standards. The calibration shall be carried out at 0, 20,40,60,80 and 100% of the range of the instrument in both increasing and decreasing directions using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. The instrument will be acceptable if the accuracy and repeatability are better than those specified. The instrument used for testing shall hold a valid calibration certificate from a recognised laboratory. The test instruments shall have accuracies traceable to the National Bureau of Standards as applicable.

2.8.4 Overrange protection test

All transmitters, digital panel meters and flow indicators shall be subjected to the over range protection test.

2.8.5 Performance test

All the instruments shall be tested by connecting to the specified power supply for the performance test.

2.8.6 Dimensional check

The dimensions of all the instruments shall be checked thoroughly and shall be tabulated in a good format.

- Wherever applicable, following dimensions shall be checked/noted for flow, pressure and

level sensors
  - Total length
  - Insertion length
  - Diameter
  - Mounting head
  - Process connection size etc.
- For panel mounted instruments, transmitters following dimensions shall be checked
  - Width
  - Height
  - Depth
  - Bezel dimensions and cut-out dimensions for panel mounted instruments etc.
- Control Panels shall be subjected for the following dimensional checks
  - Width
  - Height
  - Depth
  - Cut-out dimension for each panel mounted instrument
  - Spacing between the panel mounted instruments

2.8.7 High voltage test for control panels

The H.V. test of 1 kV AC for one minute duration will be implemented between the panel and the individual power supply feeder which shall be isolated from the respective power supply. Any reduction in voltage level or duration is not acceptable.

2.8.8 Insulation test for control panels

Insulation test will be carried out using a 500 V megger as specified below (all instruments will be disconnected from wiring)

- Between individual terminals of terminal block and ground.
- Between individual wire and ground.
- Between adjacent terminals of terminal blocks.

2.8.9 Test on control system in control panels

- The functioning of the complete control system shall be tested to demonstrate its correct operation in accordance with the Specification.
- For control system testing, the Bidder may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Engineer.
- The system shall be shown to operate correctly whatever the selection of duty and standby equipment may be.
- Conditions to be tested shall include:
  - Normal automatic operation.
  - Normal manual operation.
  - Emergency manual operation.

2.8.10 Power supply variation test

All the instruments shall work satisfactorily for the +10 % variations in the supply voltage and +5 % variations in frequency simultaneously. Accuracy and linearity shall not change.

2.8.11 Hydrostatic test

All flow sensors and pressure sensors shall be tested to withstand 150 % of the rated pressure. The sensitivity, accuracy and calibration of the sensors shall not be deteriorated at this over range. There shall not be physical damage.

2.8.12 Repeatability test

All instruments shall be subjected to repeatability test over the full range at 0 %, 20 %, 40 %, 60 %, 80 % and 100 % of the full range. Five readings for each measurement mentioned above shall be taken for calculating and establishing the repeatability.
Tests on cables

- Check details are in accordance with the specification.
- Check for physical damage.
- Megger test between each core and armour/sheath.
- Continuity check.

2.8.13 Battery & Battery Charger Panel

Battery & battery charger panel shall be subjected to all functional, routine and type tests.

3.0 TECHNICAL SPECIFICATION OF INSTRUMENTATION EQUIPMENT

3.1 ELECTROMAGNETIC FLOW METER

3.1.1 GENERAL

a) This document specifies the technical requirements of flow meters which operate on the principle of electromagnetic induction.
b) The flow meter shall consist of an in-line flow detector head and a separately mounted flow converter/transmitter for producing a current and pulse output directly proportional to the liquid flow rate.
c) The design, operation and calibration of the flow meter shall comply with the latest version of Standards as listed below or equivalent other international standards.

- BS EN ISO 6817 : Measurement of conductive liquid flow in closed conduits - Method using electromagnetic meters
- BS EN 60529 : Specification for degrees of protection provided by enclosures (IP Code)

3.1.2 DESIGN REQUIREMENTS

The flowmeter shall meet the following design requirements:

Description	Specification
Accuracy	Better than ±0.5% for flow rate ranging from 20% to 100% of the total flow of the flow meter (for potable water, sea water and raw water applications) Better than ±1.0% for flow rate ranging from 20% to 100% of the total flow of the flow meter (for slurry and sludge flow applications)
Linearity error	Better than ±0.2% of the span

Repeatability	Less than ±0.1% of the span
Calibration	Self-calibration at a frequency not less than once per day

3.1.3 Flow Detector Head

a) The flow detector head shall be flanged at both ends. It shall be suitable for installing in the pipeline between a fixed flange at the upstream end and a straight pipe edge at the downstream end by means of a flange adaptor. The detector head shall be constructed from non-magnetic material lined with a non-corrodible insulating material compatible with the liquid being measured and of the required pressure rating. The field excitation coil assembly shall be epoxy resin encapsulated. The complete housing, including cable termination, shall have a certified degree of protection to IP 68 for continuous 5 m water submersion for 8 hours. External cable connections for field excitation and signal transmission shall be made via a sealable die-cast termination box or water-tight plugs and sockets. The cable shall be screened with suitable mechanical protection.
b) Suitable earthing arrangements shall be provided at both sides of the flow meter. Where the flow meter is specified to be installed in a pipeline with cathodic protection, insulating flanges, bonding bars etc. shall be provided to avoid any electrical interference to the flow meter. Resilient gaskets shall be supplied for fitting between the flanges of the detector head and the pipeline. The gasket material shall be chemically resistant to the measured liquid.
c) The design and construction of the electrode assembly shall prevent any ingress of water into the detector coil housing.
d) A liquid sensing electrode or an equivalent device shall be provided to nullify the flow signal output when the metering tube is only partially filled with water.
e) The design parameters of flow detector head are given in the table below :

Signal cables between the flow sensor and the converter shall be screened to suppress interference and the entry at the flow sensor shall maintain watertight to IP68, to protect the coil enclosure. The interconnecting cable shall be terminated sealed on the flow sensor by the manufacturer before shipment from the factory. Empty pipe detection and reference electrodes shall be included as standard.

The design parameters are specified in the table below :

Description	Specification
Enclosure rating	IP68 for continuous 8 hours submersion at 5 m depth
Field excitation	Pulsed d.c. field from flow converter
Metering tube	Stainless steel 304
Lining material	Elastomer/ Hard Rubber/PTFE (Teflon) or other approved material suitable for use in the project.
Electrode material	Stainless steel 316
Pressure effect	Less than 0.15% over the operating range of flowmeter
Temperature effect	Less that ±0.05% of flow rate per 10oC

3.1.4 Flow Converter

a) The flow converter package shall be of the withdrawable type to allow easy access to the PCB for testing or fault diagnosis under operating conditions. Local flow rate indication shall be provided at the flow converter. Alarm contacts for high/low flow rate shall be provided. The enclosure of the flow converter shall comply with IP 65 requirement.

b) Separate analog or pulse signal outputs for forward and reverse flow applications shall be provided with a volt-free contact for indication of reverse flow condition. The flanged adaptors at both ends of the flow meter to have adequate length to enable the measurement for forward and reverse flow conditions.
c) The design parameters of flow converter are specified in the table below :

Description	**Specification**
Enclosure rating	IP 65
Input signal	Induced e.m.f. from flow detector head
Output signals	
(i) current	4 - 20 mA d.c. or 4 – 20mA for load up to 700 ohms
(ii) pulse	24V/200 mA d.c. pulses with pulse rate up to 10 pulses/sec. suitable for driving a pair of electromechanical counters each with coil resistance of 430 ohms nominal
Low flow signal cut off	Automatic output signal cut off at less than 1% of the full scale flow range with resumption of normal measurement at flow above 2%
Signal averaging time	Field adjustable between 0-5 sec
Supply voltage effects	Less than ±0.1% of the calibrated span per ±10% change in supply voltage
Frequency effects	Less than ±0.1% of the calibrated span per ±2% change in supply frequency
Temperature effects	Less than ±0.15% of flow rate per 10°C
Power supply	230V 50 Hz or 24V d.c. as detailed in the Particular Specification
Diagnostic	Self monitoring with fault diagnostic functions including self calibrating the accuracy of signal processing
Programming	Socket provided capable of linking for interface to a laptop PC computer

3.1.5 Accessories

Each flow meter shall be provided with the following accessories:

a) One set of earthing attachment for each end of the flow meter, and
b) 50m of screened cables for field excitation and signal transmission between the detector head and flow converter.

3.1.6 Calibration and Testing

a) Each flow meter shall be tested and flow calibrated on certified testing apparatus at the manufacturer's works or other approved flow calibration facility with calibrated test equipment complying to National or international standards.
b) The following tests shall be conducted: -
    - Pressure test to 150% of the required working pressure for 30 minutes
    - Flow calibration for the complete flow detector head and flow converter to verify the accuracy over the full flow range in accordance with BS EN ISO 6817. If required, separate tests shall be carried out with water flow in normal and reverse directions.
    - Degree of protection of the flow detector head to BS EN 60529 IP 68. However, type test reports/certificates can be furnished as an alternative.
c) Details of the flow calibration test including the flow meter test rig arrangement and calibration methods shall be submitted for assessment. All test results/certificates for the flow meter shall be submitted to the Employer prior to delivery of the equipment.

3.2 ULTRASONIC LEVEL MEASUREMENT

Ultrasonic type level measuring devices shall comprise of a transducer, a transmitter, remote level indicator and all other items required for the complete control system.

3.2.1 TRANSDUCER

Type - Non-contact, ultrasonic level transducer

Transducer shall meet the following requirement:

a) The transducer shall be suitable for flange or bracket mounting as required. It shall have ambient temperature compensation and adjustable datum setting facilities.

b) Transducer shall be capable of being completely submerged without damage.

c) Transducer shall be suitable for surface, pipe, or flange mounting. Appropriate mounting hardwired shall be provided.

d) Transducer shall be provided with integral temperature sensors for temperature compensation at temperature ranges from -50°C to 150°C.

3.2.2 TRANSMITTER

Type - Microprocessor based compatible with the transducer.

Weather protection	IP-65 of IS-13947 Part-1
Resolution (including transducer)	± 0.1 percent of range
Accuracy (including transducer)	± 0.25 percent of range
Range	As required by the installation
Output	Isolated 4-20 mA output and minimum of six programmable alarm contact outputs, adjustable to trip at any point in the scaled instrument range. Output contacts shall be rated 5 A at 230 VAC.
Temperature Compensation	Compensation over the temperature range of the sensor.
Display	Digital indicator displaying level/differential level or volume in engineering units or percent.
Diagnostics	On-screen instructions and display of self- diagnostics.
Loss of Signal	Transmitter shall ignore momentary loss-of-echo signals and shall indicate loss of echo on the transmitter unit.
Configuration Protection	Programmable parameters shall be protected

Prefabricated integral cable for connecting sensor and transmitter shall be included

Transmitter shall be suitable for surface or pipe stand mounting.

3.2.3 Accessories Required

a) Hand-held programmer where required for configuration and calibration of the instrument

b) Sunshield for outdoor installation

3.3 FLOAT TYPE LEVEL SWITCH

Float type level switches shall be provided for detection of high high and low low levels in the wet well. The level switches shall have top mounting arrangement with IP-68 weather protection class. The level switch shall have 2 NO + 2 NC contacts rated for 230 V AC, 2A.

Technical Particulars

Service	High High and Low Low level detection in wet well of STPs
Range	0 – 12 metres
Repeatability	± 0.1% or better
FLOAT	
Mounting	Field, on top of STPs wet well, Flanged
Flange	ANSI B16.5, 150 LBS, SS316
Material of Float	Polypropylene / SS316
Cable Material	Suitable for sewage application
Counter weight (Ballast)/ support pipe for clamping cable	Required to ensure stable vertical position of the float
Float installation hardware material	SS 316
Switch Type	Micro switch (Mercury type not acceptable)
Output	2 NO + 2 NC contact
Contact Rating	240 V AC, 2 A
Power Supply	24 V DC
Weather protection class	IP-55 of IS-13947 (Part I)

3.4 PRESSURE DEVICES

3.4.1 PRESSURE SWITCH

a) Pressure switches shall be electromechanical type which will be activated upon reaching a specific predetermined pressure setting for pumping plant and for protection and control applications.
b) The pressure set point of the pressure switch shall be fully adjustable by means of a lockable screw against a calibrated scale in metre head of water or kPa within the range of the instrument.
c) The pressure switch shall meet the following requirements:

Accuracy	Better than ±3 % of calibrated scale
Repeatability	Better than ±1 % of operating range
Over Range Protection	Over range protection to 150 percent of the maximum process line pressure.
Setpoint	Field adjustable and set between 30 and 70 percent of the adjustable range.
Output Contacts	DPDT contact rated at 10A, 230 V AC and 1 A 24 V DC
Dead band	Hysteresis (on & off) of the control loop shall be provided
Reset	Unit shall be of the automatic reset type
Housing	IP65
Switch Assemblies	Hermetically sealed switches.
Wetted Parts	316L stainless steel diaphragm, viton seals, 316 stainless steel connection port.

3.4.2 PRESSURE TRANSMITTERS

a) Gauge pressure transmitters shall be used to measure reservoir levels and pipeline pressures and differential pressure transmitters shall be used for measurement of water flows in differential pressure flow meters.
b) Gauge Pressure Transmitter measures pressure with respect to the atmospheric pressure and translates it into an electrical signal of 4 – 20 mA DC that is` directly proportional to the gauge pressure input.

c) Each pressure transmitter shall incorporate an isolation valve of suitable material.
d) The transmitter shall be provided with an indication for local indication and calibration purposes.
e) The transmitter enclosure shall be of die cast aluminium alloy suitable for outdoor installation.
f) Pressure transmitters shall be supplied with power supply units.
g) The pressure transmitters shall meet the following requirements :

Transmitter design

Accuracy	Better than 0.25% of calibrated span
Supply Voltage Effect	Better than 0.01 % of calibrated span per volt
Temperature Effect	Better than 0.03 % of calibrated span per °C
Static Pressure Effect	Zero error better than 0.25 % of maximum measurement range

Input

Range	As per requirement
Surge Pressure	Over pressure of up to 10 MPa on either side of the port without damage

Output

Span Adjustment	Continuously adjustable between 25 and 100 % of maximum measurement range
Zero Adjustment	Continuously adjustable between 0 and 10 % of the calibrated span
Damping	Output damping adjustable between 0 and 2 sec.

3.4.3 PRESSURE GAUGES

a) Pressure gauges shall comply with IS 3624/ BS 1780. For especially arduous duty where the gauge is subject to pressure pulsations and/or vibration, it shall be provided with a glycerine filled dial.
b) The internal parts of pressure gauge shall be of stainless steel material. When necessary a diaphragm seal shall be used to segregate the internal parts from the corrosive fluid media.
c) The accuracy of pressure gauges shall be ±1% over the operating range. The zero and span of pressure gauge shall not change by more than ±0.1 % of the span per degree changes in ambient temperature. The gauges shall be of precision type.

Technical Particulars

Service	Suction and discharge of sewage pumps, air blower lines, chlorine motive water pumps chlorine dosing lines, etc.
Type	Bourdon
Accuracy	± 1 % of full scale
Dial Size	150 mm
Glass	Shatterproof
Over range protection	25% above maximum pressure
Diaphragm seal	Required
Diaphragm Material	SS 316
Other Wetted Parts	SS 316
Process Connection	Flanged, SS 316, ANSI B 16.5
Accessories	Snubbers, isolation valve & drain valve Impulse tubing and fittings

3.5 pH MEASURING INSTRUMENT

a) The instrument shall be microprocessor based with the measuring system operating on the principle of electromagnetic cell using two withdraw able sealed type electrodes in which one shall be the pH measuring glass electrode and the standard reference electrode. The electrode system shall generate an electromotive force that shall vary with the concentration in the sampled solution.
b) The instruments shall be suitable for calibration using buffer solutions.
c) The electrode system of the instrument shall incorporate a device for protecting the reference electrode from contamination. Integrated temperature detector shall be provided for automatic compensation of the solution temperature and continuous temperature monitoring.

3.5.1 pH Analyser

a) The enclosure of the pH analyser shall have a degree of protection of IP65 and fabricated out of glass reinforced plastic or aluminium with epoxy finish. The analyser shall be suitable for wall mounting and operation at 230 V AC supply.
b) Stainless steel mounting brackets shall be provided for equipment installation.
c) The pH analyser shall have analogue outputs for the measured pH and the temperature of the sampled solution. The analogue output signals shall be 4-20 mA DC capable of driving a 500 ohm load for remote indication and recording.
d) A 4-digit backlit LCD indicator shall be provided with the analyser for instant display of measured pH and temperature values. Two signal limit alarms adjustable from 0 – 100 % of the whole measurement range and one equipment failure alarm shall be provided. Alarm of the analyser shall include local alarm indication and a volt free relay output contact rated at 2A, 230 V A.C. for remote alarm annunciation.
e) Dedicated control keys shall be provided at the pH analyser to allow configuration, calculation, interrogation and access to the built in functions of the pH measuring system.

3.5.2 pH Sensor

a) The sensor shall operate on low dc voltage provided by the analyser and shall include an integral pre-amplifies for amplification of measured signal.
b) The sensor shall be supplied with enclosure fabricated from chemical resistant materials suitable for operation with the sampled solution. Electronic components and wiring terminals shall be installed in an isolated compartment sealed off from the wetted parts. Control cable shall be provided for connecting the sensor to the pH analyser.
c) Flow through pH sensors shall have IP 65 enclosure suitable for wall mounting by stainless steel brackets.
d) Dip type pH sensors shall have IP 68 enclosure. Removable guard for protection of pH measuring electrodes and all stainless steel mounting accessories shall be provided for installation of equipment.
e) An automatic acid cleaning system in the form of spray head cleaning with dilute acid shall be incorporated with the pH sensor to prevent coating or build-up of deposits. The cleaning system shall be suitable for prolonged operation without maintenance and shall not affect the accuracy of the instrument. The initiation shall be based on timer or self- diagnostic feedback signal. All accessories required for automatic cleaning system, such as self-cleaning sets, hose pumps, injector and spray head etc. shall be provided.

Technical Particulars

pH Analyser	
Accuracy	0.75 % of measuring range
Sensitivity	0.01 pH
System response time	10 sec for a 90 % pH step change

Measuring range	0- 14 pH, 0 - 100°C
pH Sensor	
Sample temperature	0 – 50 °C
Sample conductivity at 20°C	25-300 uS/cm
Operating Pressure	Up to 600 kPA

3.6 TURBIDITY METER

a) Turbidity meter shall be used to measure the concentration of suspended particles in water. Light scattering principle to ISO 7027 shall be employed for turbidity measurement. The turbidity measuring system shall be microprocessor based consisting of a continuous process nephelometer in which a single wave length light beam shall be emitted from an infrared LED source for passing through the water sample with measurement to be made on the amount of light scattered 90 degree by the turbidity particles.
b) The instrument shall be designed to avoid erroneous readings caused by stray light, air bubbles, course particles and electromagnetic interference.
c) Connecting cables between the turbidity sensor and transmitter shall be supplied. The allowable distance between the sensor and transmitter shall be not less than 15 m.
d) The instrument shall be capable of being calibrated by means of standard solutions or a secondary device being placed in the light path.

3.6.1 Turbidity Sensor

a) Turbidity sensor shall operate on low dc voltage derived from the turbidity transmitter.
b) The enclosure of turbidity centre shall be fabricated from chemical resistant materials compatible with sampled water.
c) Electronic components and wiring terminals shall be installed in an isolated compartment sealed off from the wetted parts of the measuring instrument. The detector head assembly shall be removable from the sensor body for inspection and maintenance.
d) A mechanical wiper shall be built-in with the turbidity sensor for automatic cleaning. The cleaning time and frequency shall be adjustable and programmable at the turbidity transmitter.
e) Flow through type of sensor shall have IP65 (BS EN 60529) enclosure suitable for wall mounting by stainless steel brackets. Integrated bubble trap shall be provided with the sensor to eliminate any incoming gas bubbles before the sample water enters the measuring chamber to enhance the accuracy in measurement. A drain clock shall be provided at the bottom of the instrument.

3.6.2 Turbidity Transmitter

a) The transmitter shall have IP 65 enclosure and fabricated from glass reinforced plastic or aluminium with epoxy finish. The transmitter shall be suitable for wall mounting.
b) The transmitter shall have a 4-20 mA dc analog output capable of driving a 500 ohm load for remote indication and recording.
c) A 4-digit backlit LCD indicator shall be provided with the transmitter for instant display of the measured turbidity value shall be provided. Two signal limit alarms adjustable from 0 – 100 % of the whole measurement range and one equipment failure alarm shall be provided. Alarm of the transmitter shall include local alarm indication and a volt free relay output contact rated at 2A, 230 V A.C. for remote alarm annunciation.
d) Dedicated keys shall be provided at the transmitter to allow configuration, calibration, interrogation and access to all built-in functions of the turbidity measuring system.
e) The equipment shall be suitable for operation at 230 V 50 HZ AC supply.

f) Stainless steel mounting brackets shall be provided for installation of equipment.

The turbidity meter shall generally comply with the following specification requirement :

Principle of operation	Nephelometric
Range	0 – 10,000 NTU
Accuracy	± 2% of reading plus 0.01 NTU (0 to 1000 NTU) ± 5% of reading (1000 to 4000 NTU) ± 10% of reading (4000 to 10,000 NTU)
Resolution	0.0001 NTU on Lowest Range
Response Time	less than 6 seconds
Ratio (Color Correction)	Full Time ON or OFF
Light Source	Quick connect Infrared
Sample Size (Volume)	30 ml
Air Purge	Connection for external dry air supply
Calibration	1 to 3 Points (automatic)
Repeatability	< ±1 % of reading
Outputs	RS-232 Serial Port

4.0 GENERAL TECHNICAL SPECIFICATION - SCADA

4.1 GENERAL

This document, in conjunction with the detailed technical specifications, describes the main functions and features of the SCADA and Instrumentation System and its associated equipment and cables. The Contractor shall implement these functions and features, both tailored to the requirements specified in this document and that actually required at the various locations.

4.3 BASIC FUNCTIONAL REQUIREMENTS OF SCADA SYSTEM

a) Collect, store and accurately analyse, reliable operating information in respect of pressure, flow (instantaneous and integral), level etc. of the entire water distribution network.

b) Perform real time process control, timer initiated events, process initiated events, system and program initiated events, operator initiated events, concurrent tasking and time tagging of inputs.

c) Assist operating personnel by alarm from abnormal operating conditions and equipment failure.

d) Acquire all measurements and perform all necessary calculations based on automatic and manual operator data inputs.

e) Accumulate and store equipment running times, transactions and changes in process, store information for use in preventive maintenance, management and inventory control

f) Store and retrieve all O&M information, manuals (both data and graphics)

g) Compile and prepare daily, weekly, monthly reports.

h) Manage and schedule all O & M functions.

4.4 CONTROL PHILOSPHY

The SCADA system shall be designed such that:

a) The water supply system shall be instrumented to the extent required to allow automated,

unmanned operation.

b) Process operations shall be automated, controlled by process control strategies executing in PLCs.

c) Redundancy shall be provided for PLC's so that failure of any PLC will not affect the process area, thus allowing continuous operation of the plant facility.

d) The system shall have facility such that In the event of PLC failure, it shall be possible to operate all equipment locally by use of manual controls.

e) Remotely located PLC control panels shall be provided for enabling control of the process parameters.

f) In the event of a process network failure the PLC will continue to control equipment.

The bidder shall submit with the bid a brief outline of the control philosophy proposed for the SCADA & Instrumentation System.

The successful contractor shall submit an exhaustive Control Philosophy immediately on commencement of works. The extent of instrumentation shall be as defined in the following Drawings:

a) Piping & Instrument Diagrams

b) Instrumentation Drawings

c) Other related documents.

The Instrument List shall be developed by the contractor during detail engineering phase. The instrument list shall cover the instrument provided by contractor and shall include all tagged instruments, together with relevant data and reference document information.

4.5 CONTRACTOR TO INFORM HIMSELF FULLY

The contractor should ensure that he has examined the General Conditions, Specifications and Schedules as brought out in other sections of the bid document and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied.

The Employer shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Employer.

Site Locations - The Contractor may undertake site visits and obtain all required information before the submission of the bid.

4.6 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS

The contractor shall note that all electrical works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, in regard to the rules and regulations that may be applicable.

4.7 STANDARDS

a) It shall be the responsibility of the Contractor to ensure that the quality and specification of the equipment, materials and works are as per the latest revisions of national and international standards like IEC, IEEE, NEMA, etc. In case the requirements specified in this document are

less stringent than the national or international norms or standards. the equipment covered by this specification shall, unless otherwise stated, be designed, manufactured and tested in accordance with the latest revisions of relevant Standards and shall conform to the regulations of local statutory authorities.

b) The standards referred to in the Specification shall govern in all cases wherever such references are made. In case of any conflict between such standards and this specification, the Contractor shall immediately point out the same to the Employer and seek clarification on the same.

c) Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately.

4.8 CONTRACTOR'S Liability

a) The Contractor should be in possession of a valid License from the Govt. of Rajasthan before commencement of the Work, failing which the Work Site will not be handed over to the Contractor.

b) The Govt. of Rajasthan or his Authorized Representatives may inspect the sites during construction. It is the responsibility of the Contractor to obtain pre-requisite formal clearance/ approval from the said Inspectorate prior to commissioning of any equipment. The Employer may assist the Contractor in obtaining the aforementioned approvals

c) The furnishing of data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

d) All data submitted by the Contractor after review by the Employer shall be part of the contract document.

4.9 DATA SHEETS

All data sheets appended to bidding documents must be completely filled in by the bidder. The bidder shall specifically note that incomplete information or non-supply of important information may result in rejection of his bid.

4.10 DRAWINGS AND DATA TO BE SUBMITTED WITH BID

The Contractor shall submit along with the bid all drawings and other data as stated in different sections of this document. These drawings and documents shall include sufficient details to demonstrate fully that all supplies and works included in the Contractor's scope shall conform to the provision and intent of these specifications. These drawings and documents shall provide sufficient details of the equipment, its description, type, size, Bill of Quantities, etc. Information related to arrangement, overall dimensions clearance etc. required for assembling and dismantling and furnishing the space requirements of all apparatus shall also be included to enable the Employer to determine the design and layout of the installation and to decide the compatibility of the bid.

4.11 DRAWINGS AND DOCUMENTS FOR APPROVAL

In addition to those stipulated in clause regarding drawings in General Conditions of Contract (GCC)/ Special Conditions of Contract (SCC), the following also shall apply in respect of Contractor Drawings:

a) All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

b) Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

c) The drawings submitted by the Contractor shall be reviewed by the Employer as far as practicable and shall be modified by the Contractor if any modifications and / or corrections are required by the Employer. However, it shall be the responsibility of the Contractor to review the proposed changes and point out any possible problems such as conflict with existing standards, etc. before incorporating the changes so that no technical problems may arise. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good line shall not alter the contract completion date.

d) The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.

e) The drawings submitted for approval to the Employer shall be in requisite number of copies.

All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the drawings shall be at the Contractor's risk. In case the contractor finds the necessity of making any changes in the design, such changes will again be subject to approval by the Employer. The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:

a) The Contractor has completed the part of the Works covered by the subject document.

b) The Works appear to comply with requirements of Specifications

In no case the approval by the Employer of any document does imply compliance with neither all technical requirements nor the absence of errors in such documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

The following is an exhaustive list of the documents and drawings that are to be submitted by the contractor:

a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.
b) System Configuration Diagram
c) General Layout of Control Centre Equipment
d) General layout of each field station
e) Function design document of all equipment.
f) Hardware description documents.
g) Data Sheets of each equipment, cables & auxiliary equipment
h) Bill of Quantities
i) I/O list
j) General arrangement drawing with full dimensions of panels
k) Instrumentation Drawings

l) PLC/ HMI programming standards
m) Software details
n) Test procedures
o) Cable Layout and details.
p) Cable and wiring schedule, as applicable.
q) Wiring diagram, where applicable.
r) Communication cables details.
s) Earthing layout and details.
t) General layout of each station
u) Training documentation/ Training Manuals
v) Operation & Maintenance Manuals
w) Any other drawing/ document that is considered necessary for Employer's information/ approval.

All Designs / Drawings / Calculations/ Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts / works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

The drawings submitted for approval to the Employer shall be in requisite number of quantities. One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections". The contractor shall there upon furnish the Employer additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.

4.12 FINAL DRAWINGS AND DOCUMENTS

The successful Contractor shall be required to provide following drawings and documents in requisite type and quantities as per the requirements of the project:

a) All approved drawings of equipment and works related to a particular station.

b) Instruction manuals of all equipment that shall generally consist of:

- Operation Manuals,
- Maintenance Manuals,
- Spare Parts Bulletins.
- Copies of routine test reports of relevant equipment.
- Final Guaranteed and Other technical particulars of relevant equipment.
- Final list of software applications and configuration details of those applications as downloaded for each station.

c) Copies of type tests and routine test reports of relevant equipment.

d) Final Guaranteed and Other technical particulars of relevant equipment.

e) Final list of software applications and configuration details of those applications as downloaded into Fs for each substation.

f) Backup copies of all system configurations (F)

4.13 AS BUILT DRAWINGS

After the completion of the onsite erection work, the contractor shall furnish requisite copies of the 'As Built' drawings showing changes, if made, during erection for reference and record of the Employer.

4.14 DESIGN CO-ORDINATION

Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best co-ordinate performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

4.15 DESIGN IMPROVEMENTS

The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

4.16 QUALITY ASSURANCE AND QUALITY CONTROL

a) The contractor shall maintain quality control over suppliers, manufacturers, products, equipment, software, services, site conditions, and workmanship, to produce work of specified quality. The system provider shall maintain adequate records to provide evidence of quality and accountability. These records shall include results of inspections, tests, certification of processes and personnel, discrepant material and other quality requirements. These records shall be maintained and made available to the Employer at all times during the performance of the project and for the retention period as specified in the project. Inspection and testing records shall, as a minimum, indicate the nature of the observations, the number of observations made, and the number and types of deficiencies found. Records for monitoring work performance, inspection, and testing shall indicate the acceptability of work or products and the action taken to correct deficiencies. The records shall be retrievable and traceable from a component failure to demonstrate its original acceptance by test, inspection, and the criteria used.

   The Contractor shall get the quality plans finalised and approved after the award of the Contract. The approved quality plan shall form the basis for inspection and acceptance of the equipment. The Employer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval.

b) Quality Assurance Plan for Site Installation & Commissioning

   The contractor shall submit with the bids Quality Assurance Plan giving details of stage inspection during installation, pre-commissioning and commissioning tests and customer witness / hold points. The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. Test Procedure shall be specified giving for each test item (kind of test) a description, test method / standards, used instruments, sample/routine test, etc. The tests will also include the applicable standards and acceptance criteria.

c) Quality Assurance Documents

   The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employers inspection of equipment/material. The Employer or his duly authorized representatives reserves the right to carry out Quality

Audit and quality surveillance of the systems and procedures of the Contractors/his vendors Quality Management and Control Activities.

4.17 SPARE CAPACITY

The system shall have 20 % spare capacity for all types of input/output modules. Spare I/O channels of modules shall be wired up to terminal blocks as defined in this document.

4.18 SPARE PARTS

a) Recommended Spare Parts

The Contractor shall furnish an item wise list of recommended spare parts and quantity for three years satisfactory operation of the equipment with unit price of each part in a separate Schedule. Prices of these spare parts shall not be taken in to account in comparing Price Bid. Also, they will submit an undertaking to supply all spare parts for a minimum period of 10 (ten) years as and when any request is made before them on a chargeable basis.

b) Mandatory Spare Parts

The contractor shall also quote for the mandatory spares list. Prices of these spare parts shall be taken into account in comparing price Bid.

4.19 CONSTRUCTION TOOLS & TACKLES

Contractor shall provide all required tools for enabling connection with any other intelligent device of which protocol, message structure, message organisation are known so the field station can scan the device and transmit the data to the control centre when polled. The Contractor shall submit a list of all such materials to the Employer before commencement of work at site. These tools and tackles shall not be removed from the site without the written permission of the Employer

4.20 VENDOR LIST

Reference shall be made to the **Preferred Vendors list**. Equipment to be supplied and not covered or which does not conform to this list due to the manufacturer's own standards shall be submitted for approval.

4.21 REFERENCE STANDARDS

The system and equipment shall be designed, built, tested and installed to the latest revisions of the applicable standards. The table below gives a non – exhaustive list of the reference standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed Engineering for the purpose:

IEC 60051	Recommendations for indicating electrical measuring instruments and their accessories
IEC 60065	Safety rules for electrical devices connected to a network procedures
IEC 60255	Electrical relays

IEC 60326	Printed boards
IEC 60332	Flame retarding characteristics of electric cable
IEC 60337	Auxiliary devices for control
IEC 60478	Level of spurious signal emission Stabilized power supplies, DC output
IEC 60529	Degree of protection
IEC 60617	Symbols on Electrical drawings
IEC 60625	Interface system for programmable measuring instruments (byte serial, byte parallel)
IEC 60721	Conditions of environment
IEC 60793 Part 1	Optical Fibre- Measurement and test procedures
IEC 60793 Part 2	Product specifications
IEC 60847	Local area network characteristics
IEC 60870	Telecontrol equipment and systems
IEC 60950	Equipment safety
IEC 61000	Electromagnetic compatibility for industrial process - measurement and control equipment
IEC 61131	Programmable Controllers
IEC 61158	Digital data communications for measurement and control - Fieldbus for use in industrial control systems
ISA S5.1	Instrumentation Symbols and Identification
ISO 2110	25-point connector
ISO 8802	Information process systems
ISO 9000	Quality management and quality assurance standards
ISO 9001	Quality systems: Model for quality assurance in design / development, production, installation and services
ISO 9002	Quality systems: Model for quality assurance in production and installation
ISO 9003	Quality systems: Model for quality assurance in field inspection and tests
ISO 11064	Ergonomic Design of Control centres
IEEE 1046	Application guide for distributed digital control and monitoring for power stations
ANSI / IEEE C37.1.1987	Definition, specification and analysis of systems used for supervisory control, data acquisition and automatic control.

4.22 ENGINEERING DATA

The furnishing of Engineering data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

All Engineering data submitted by the Contractor after review by the Employer shall be part of the contract document.

4.23 GURANTEED TECHNICAL PARTICULARS

The contractor shall fill up the Questionnaire for Guaranteed Technical Particulars of each item of the equipment as given in Annexure contained in Section-F (SCADA Master Control Station) of this document. The Contractor shall fill up the required particulars in these Annexure and submit the same with the technical bid. The Contractor shall also furnish with the bid all other details as specified in different sections of this document. Any other information which in the opinion of the

Contractor is required by the Employer for better understanding of the equipment offered shall also be submitted with the bid.

4.24 COMMISSIONING SPARES

It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.

4.25 TRAINING

It is important that Employer's personnel be adequately trained in the installation, operation, maintenance and expansion procedures and techniques of the supplied system. The training program shall be comprehensive and provide for interdisciplinary training on hardware and software. The training program shall be conducted in English. F training course shall cover the following:

a) operation including data flow.

b) Troubleshooting, identification and replacement of faulty Modules.

c) Preventive maintenance of the

d) Use of configuration and Maintenance tool

e) All functional and Diagnostic testing of

f) Database modification and configuration of

The details of the training, training duration and the number of personnel shall be mutually discussed with the successful contractor.

Training Material

Comprehensive training manuals shall be provided for all training courses and the course material presented in a format that is easy to comprehend. The manuals shall serve as teaching aids during presentation of the training classes and as reference material after the training has been completed. It is not recommended that the Contractor use system technical documentation solely as the training manuals since system documentation is generally not written in an instructional format. Portions of system documentation may be incorporated into training manuals provided that the overall manual achieves an instructional format.

4.26 TYPES OF TESTS

The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

a) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to Commencement of commercial production against the order. The contractor shall indicate his schedule for carrying out these tests.

b) Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

c) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.

d) Tests during Manufacture shall mean those tests, which are to be carried out during the

process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.

The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed between the Contractor and the Employer

4.27 TYPE TEST REPORTS

All Bids must be accompanied by the Type Test Certificates of equipment offered. Such type test certificates shall be acceptable only if :

a) Tests are conducted in an independent and well known testing laboratory,
b) Tests are conducted in manufacturer's own laboratory. In this case the laboratory must have ISO 9000 (or its equivalent) series certification; tests have been witnessed by technically qualified representatives of earlier clients or purchaser.
c) Test reports to be acceptable must be related directly to the equipment offered. Test reports for higher class of equipment are acceptable with commitment to perform the type tests free of any charge on the particular equipment(s) after the award of contract.
d) Type tests certificates are required for following equipment:
   x) Main processor unit
   xi) I/O modules
   xii) Power supply modules and charges
   xiii) Communication interface modules
   xiv) HMI (Human-Machine Interface) display unit
   xv) Modems
   xvi) Converters
   xvii) Any other equipment considered necessary by the employer

Type Test Reports older than five (5) years on the date of Technical bid opening shall not be accepted.

4.28 SYSTEM TESTING

As part of the requirement of this specification section, it is the responsibility of the contractor to provide a complete operational control system. It is required that:

a) The contractor demonstrate that the system was fully tested during development and installation and is a functioning, integrated, and reliable system. The testing requirements require a comprehensive and progressive series of contractor conducted tests, contractor certifications, and Employer's witnessed tests.
b) The basic testing requirements shall require the contractor to provide tests for all equipment and software. All software and all equipment including mechanical, electrical, and all other equipment shall be tested both individually and together as an integrated system.
c) All tests shall be conducted in accordance with the relevant standards / Employer approved test procedures, forms and check lists submitted by the contractor.
d) As a minimum, the testing shall include the following:
   - Factory Acceptance Testing (FAT)
   - Site Acceptance Testing (SAT)

Items of equipment/ system not covered by standards shall be tested in accordance with the details and program agreed between the Employer and contractor.

4.29 FACTORY ACCEPTANCE TESTING (FAT)

A Factory Acceptance Test and verification for all deliverable equipment, software, and associated documentation shall be performed prior to shipment of subsystems or major components. The equipment factory tests shall be performed to verify that the equipment is manufactured and assembled correctly, is operating as designed, and is in compliance with the contractual requirements for the deliverables. The factory test shall be performed to verify that the software and hardware will meet the functional and performance requirements of the complete project. The system shall (as a minimum) be tested for the following:

a) Operation requirements

b) Operating characteristics

c) Response times

d) Software functions

e) Deficiencies - Various process signals shall be simulated for carrying out above system tests.

The contractor shall submit a FAT test procedure to the Employer for approval prior to start of the FAT.

4.30 SITE ACCEPTANCE TESTING (SAT)

a) A Site Acceptance Test of the functions, software, and performance shall be conducted individually at each site (or facility process) after all elements have been installed and the I/O Point Checkout has been completed at each site.

b) The system Site Acceptance Tests shall be performed to verify complete operation of the system, requiring a repeat of much of the factory acceptance tests but with the equipment installed at the permanent sites, and shall include additional tests required to verify field-installed equipment which was not available at the factory.

4.31 INSPECTION & INSPECTION CERTIFICATE

a) The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have, at all reasonable times, access to the premises and works of the Contractor and their sub-contractor(s)/sub-vendors and shall have the right, at the reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.

b) The inspection of all equipment/systems required to be supplied to complete the works shall be done as detailed in this Specification. Only defect free and sound material meeting the technical requirements of this Specification and in accordance with a high standard of Engineering would be acceptable to the Employer's Representative.

c) For meeting these requirements of inspection, testing shall be carried out by the Contractor and certificates submitted to the Employer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Valid calibration certificates for test instruments shall be produced for the Employer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of equipment/ system not covered by standards shall be tested in accordance with the details and program agreed between the Employer and Contractor.

d) If during or after testing any item of the equipment/ systems fails to achieve its intended duty of otherwise prove defective it shall be modified or altered as necessary, retested and re-inspected as required by the Employer.

e) No equipment/system is to be delivered to Site without the above described inspection having been carried out or officially waived in writing by the Employer's Representative.

f) The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the Contract.

4.32 GUARANTEES

The contractor shall be responsible to replace, free of cost with no transportation and insurance expenses to the Employer up to the destination of materials specified in schedule of dispatch, the whole or any part of the material which under normal and proper use and maintenance proves defective in material or workmanship for a period of three years for all SCADA Hardware equipment/ devices and five years for all SCADA Software from the date of "Employer's Taking Over". This shall override the warranty periods as defined in the General Contract Conditions. Such replacement shall be effected by the Contractor within a reasonable time actually required to do so. Contractor's liability upon the expiration of the period mentioned above shall terminate.

5.0 DETAILED TECHNICAL SPECIFICATIONS OF SCADA SYSTEM

5.1 PRIMARY FUNCTION

The SCADA system shall be the operational interface to support the operation of the complete water pipeline network under Water Supply facilities for Udaipur Smart City Project. The system shall provide the capability to acquire pipeline, pumping stations and water treatment plants operating conditions and status, remotely controlled operations, show abnormal or alarm conditions and to produce screen based or hardcopy reports.

The SCADA system shall monitor and control the entire water supply system including pump houses, treatment plants, reservoirs, distribution network, etc. The following is a broad, non-exhaustive list:

a) Analog values for all major process variables such as flow, level, and pressure
b) The status of all major process equipment such as pumps, blowers, compressors, like Pump Start/ Stop, Valves Open/ Close, etc.
c) The status of all process variables or equipment monitored or controlled by a PLC.
d) Pressure/Level high/low alarms
e) Controller set points
f) The status of all Hand/Off/Remote switches.
g) Limit switches on all computer controlled, two-state valves (both open and closed).
h) Limit switches on all valves and gates used for flow routing and other critical equipment.
i) Valve position for all valves which position is adjusted by the control system.
j) Equipment failure alarms.
k) Communication failure alarm
l) Any other parameters that are required for management and operation of the water supply facility.

The system shall enable the process information to be made available to the operator in the form of various displays and print outs, either automatically or on demand by the operator. The display selection process shall be optimized so that the desired display can be selected by the

barest minimum of key strokes by the operator. Track ball/mouse facility shall be provided for cursor control purposes.

5.2 WATER SYSTEM MONITORING GUIDELINES

The following are broad guidelines required to be met by the control system :

a) All equipment involved with the process or in support of the process should be instrumented as necessary to provide flows, levels, speeds, pressures, temperatures, positions, and equipment status..
b) All process parameters such as flows, pressures, levels, etc. are to be transmitted to the HMI at the control centre. These shall also be displayed (as required) on the local panels.
c) The status of major process equipment is also to be transmitted to the control centre and displayed at the HMI workstation. The status to be also displayed locally (as required).
d) The status of auxiliary systems, such as HVAC, Electrical Power Distribution etc. should be monitored as required by the facility operating procedures and requirements.
e) All process and equipment faults and abnormal situations shall be indicated and alarmed at the PLC panel and also on the HMI workstation at the control centre.
f) All alarms are generated within the PLCs and transmitted to the control centre.
g) Interfaces must provide not only process information but also status information. All pumps, valves, and like process equipment shall transmit signals to the SCADA system which define the equipment's state of readiness, operation status, and control mode.

5.3 DATA ACQUISITION

The data acquisition function shall provide all the aspects needed to support data collection from the field including the requesting of data from Programmable Logic Controller (PLC) and the processing of analog and digital data received from the PLC.

The data items listed below are representative of the data required from the various types of stations.

- Pressure
- Level
- Volumetric flow rate, mass flow rate, energy flow rate
- Integral flows
- Controller set points
- Pump Start, Stop, Valves Open, Close and Remote/Local status
- Pressure/Level high/low alarms

For some devices e.g. for valves, it shall be possible to use two digital inputs i.e. open status and close status to derive four states of the valve – Open, Close, Travel and Error.

5.4 USER INTERFACE CONTROL

The Operator should have control of all major equipment and process set points from the control centre or PLC panel. The Operator shall be able to respond to process changes or alarms by operating valves, turning on pumps and motors, and changing the set points. Control shall be executed primarily through the HMI at the control centre and as a backup, through the PLC.

5.5 REAL-TIME CONTROL AND ADJUSTMENT

All control and adjustment actions shall be validated by operator before execution.

From the Operator Workstations in control room, the operator shall have the possibility to perform real-time control and adjustment for all equipment of the scheme. To this end, it shall be possible for him to:

- enter Assigned Set Points,
- give direct orders,
- modify operating parameters

Assigned Set Points shall be for immediate action, and shall be maintained until a new assigned Set Point is received.

Orders shall be on/off controls entered by the operator to the SCADA system for processing. Orders shall be for example:

- start-up and stop of the units,
- change of control mode,
- change of priority for start-up or stop a unit, or for a component such as a pump,
- opening and closing of a valve or gate.

5.6 CONTROL MODES

Control Modes shall be coordinated through the use of LOCAL-OFF-REMOTE switches. These are:

- LOCAL: Changes to process equipment are initiated from the L-O-R switch. A pump in the LOCAL position shall be controlled through the local START and STOP buttons. A valve may be opened and closed through the local OPEN and CLOSE buttons or a switch.
- OFF: All local commands to the device are disabled. A running pump will stop when switched to the OFF position.
- REMOTE: Changes to process equipment are initiated from the PLC or Control Centre. The REMOTE control mode shall have two states, changeable between Control centre HMI and PLC panel
- SCADA-MANUAL: Changes to process equipment are initiated by an Operator.
- SCADA-AUTO: Changes to process equipment are initiated by a control strategy available in the PLC logic.

5.7 CONTROL TIME-OUT

Maintenance mode procedures shall be provided to modify the time-out periods associated with the various types of device control. These time-out periods shall include a maximum time for the operator to select a control action after device selection in which case the entire control request shall be cancelled. The maximum anticipated time to receive a device status change after a control sequence has been completed shall be adjustable under the system maintenance mode.

5.8 CONTROL DISPLAYS

The operator shall normally monitor the water supply system network through these displays. The displays shall be organized in the form of network overview display, group displays, individual process display and object displays. The master station will issue commands to valves and/or pumps through respective RTU's. The change of status will be sent back to the MCC (and also to SCC concerned, if required) and also to verify that the command has been executed.

It shall be possible to display mimic diagrams which represent pipeline network in color graphic form of various systems/sub-systems.

The control display shall have the following features:

a) Updation of dynamic information every second.

b) Display (in red color) of the alarm variables.

c) It shall be possible to change the color and flash the variables and equipment symbols to indicate alarm or change of status.

d) It shall be possible to include bar charts and trends as part of mimic diagrams or construct pictures containing only bar charts and trends.

e) The minimum number of mimic diagrams to be displayed shall be 100.

5.9 REPORT BY EXCEPTION

All analog and status data shall be requested on a report by exception basis to avoid unnecessary processing when the analog dead band has not been exceeded or no status changes have occurred. This is to avoid unnecessary data communication between PLC & SCADA system. Depending on the database downloaded to the individual PLC, a PLC will scan the I/O points and determine the points to be reported when polled by SCADA system.

The analog dead band, de bounce time, backup report update time, etc. shall be configurable as part of database definition. Further, it shall be possible to use integrating dead band for analog data to ensure that even small changes shall cause transfer after some time when the value is stable.

5.10 DATA REQUESTS

The SCADA system shall be capable of periodically polling all PLC's with data request messages according to polling information in polling tables. It shall be possible to define a PLC or PLCs more than once in a polling table per data channel.

PLC's shall be polled by the SCADA system for status change, analog data change and totaliser value update within every 30 seconds including envisaged future expansion.

Polling tables and polling sequences shall be subject to approval by the Purchaser.

5.11 SCADA SYSTEM POLL MODES

In addition to the general polling requirements outlined above, several other poll modes (user configurable) shall be implemented. They are:

- demand poll – to enable an update of a group of points at the operator's request.
- fast poll – to enable update data from a particular station on an immediate basis.
- to enable fast updates of data required for various applications.
- poll inhibit – to enable individual points or complete PLC's to be disabled from the polling function.

5.12 DATA GROUPING

The data at any PLC shall be grouped according to its priority and use from operating point of view and SCADA system polling frequency assigned to each group of data. The polling frequencies

shall be individually adjustable from one poll each 15 seconds to one poll each hour in increments of 10 seconds, for different groups of PLC data. Grouping of data and polling frequency shall be user configurable.

a) Report by exception data shall be updated maximum within 30 sec.

b) Backup update reports are user configurable once every 30 minutes onwards.

5.13 DATA PRIORITIES

The retrieval of status data shall have a higher priority than the retrieval of analogue data and check back execute indications of just completed control actions shall have the highest priority.

5.14 DATA VALIDITY

The SCADA system shall include an analogue data validity analysis function. This validity analysis shall be for out of range or unreasonable values. Maintenance warnings shall be displayed and logged to indicate these events.

5.15 DEVICE CONTROL SELECTION

Control requests initiated by the operator shall pass control point identification and the required control action to the control software. The software shall validate the control point and the control action required according to system status, any defined interlocks and assigned responsibilities. Error messages shall be displayed if the operation is not permitted.

5.16 DATA INTEGRITY

The data request software shall generate PLC data integrity poll to enable the checking of the integrity of stored data in the database at the PLC. The integrity poll shall be initiated periodically according to polling tables and after major pipeline system status changes, PLC power failure and major computer system events including restart and fail-over. Also a point defined for backup update reporting shall update its value/status, if it did not report by exception in a given time (user definable).

5.17 TELEMETRY FAIL AND POLL INHIBIT

Reliable detection and correction mechanism shall be implemented for data communication. If valid data is not received from a PLC in response to a poll request, the software shall attempt retransmission of data from that PLC. The number of re-polls to be attempted shall be adjustable by the maintenance procedures for each poll period.

If a PLC or its communication channel fails, all individual points at that PLC shall be marked in the database to indicate telemetry failure but only one alarm shall be generated. The database shall retain the last good value or status for every point affected until the telemetry returns to normal. Return to normal alarm shall be generated and PLC shall update (when polled) with respect to all points.

The operator shall have the capability to inhibit any point from scanning or an entire PLC from poll processing. In this situation the operator may substitute values for the data for points with defective telemetry or which have been inhibited for poll processing (substitution shall be prohibited for a point in poll and judged to be valid). Alternately a point taken in manual mode shall automatically put the point off scan. The substitute value shall be retained until poll processing on that point or station is restored.

The status of the data values (valid, subject to telemetry failure, substituted etc.) shall be indicated in the database and shown on MMI displays and printed logs.

5.18 COMMUNICATION PROTOCOL & POLLING MECHANISM

SCADA system shall poll each PLC according to a fixed protocol on that channel on continuous basis. The protocol should support dynamic allocation of telemetry cycles for effective utilization of channel bandwidth. It is envisaged that report by exception technique with specific data polling in the background is offered. The protocol shall permit alarms and analog values that have changed since last poll to be time tagged as per PLC time and sent to SCADA system ensuring minimum time between successive PLC polls and orderly transmission of all data during time of peak activities. The protocol structure shall support up to minimum 256 PLCs dispersed on multiple communication channels. Messages to and from the field shall be transmitted over these channels concurrently and asynchronously.

The protocol should support all standard data types. Command sent from SCADA system to PLC shall interrupt the upcoming stream of data on the completion of current data frame to ensure good system, response. An all stations call shall allow the SCADA system to address all the PLCs simultaneously.

The protocol shall ensure that all the messages are received without communication errors and that the messages are transmitted in correct priority basis and integrity of transmitted data is ensured through multiple error detecting codes to prevent errors and use error correcting codes in conjunction with acknowledge/negative acknowledge handshake on each transmission. Error detection codes shall be BCH or CRC message checksum codes.

5.19 RESPONSE TIMES

The protocol and polling mechanism is required to meet response times as under:

a) Time for transferring all changes of states of equipment and alarms of the entire pipeline not exceeding 15 seconds.

b) Time for updating display of any single selected analog variable or digital measurement not exceeding 2 seconds.

c) Time for execution of any controls not exceeding 2 second from the time operator initiation has taken place.

d) Time for complete data basis polling/processing/update/logging for the entire pipeline network not exceeding 30 seconds.

e) The communication frame structure definition shall be as per IEC/ISO 870-5-101.

f) Updation time of any graphic display on colour VDU not to exceed 2 sec.

g) Updation of trend displays shall not exceed 5 sec.

h) Mimic data shall be updated once in every 30 sec.

5.20 ERROR DETECTION

Error detection facilities shall be provided at SCADA system for detection and rejection of corrupted or lost telemetry signals. This facility should have equivalent to IEC TC57 or detecting errors.

In the event of failure of an interrogation request/reply cycle the SCADA system shall automatically try again and retransmit. It shall be possible to assign numbers of retries which will be limited to a maximum of 5 retries and shall be system configurable.

5.21 AUDUBLE AND VISUAL WARNING SIGNALS

The SCADA system shall be equipped with the following audible warning signals. Intensity of sound level shall be adjustable.

1. ALARM - This takes the form of a continuous 2900 Hz tone pulsing 2.5Hz. This shall operate for any field plant initiated alarm. This warning signal shall be capable of being silenced by operation of a `silence' button on the local keyboards.
2. ALERT - This shall take the form of 2900 Hz tone, 3 seconds duration. This shall operate for any condition similar to Alarms, but derived and initiated from system software. This warning signal shall automatically re-set after 30 seconds by the software, provided a further Alert condition has not been detected.
3. It shall be capable of being silenced by operation of a `Silence' button on the local keyboards.
4. CHANGE OF STATE – This shall take the form of a single beat gong. It shall operate on detection of any plant change of state not classified as alarm.

This `Silence' action shall be separate from an Alarm or Change of State `Acceptance' action and a `Silence' action shall not effect an `Acceptance', but an `Acceptance' shall effect a `Silence' action if not previously activated.

Silence' actions shall not be event logged but `Acceptance' actions shall be event logged.

5.22 SELECT-CHECK-BACK-EXECUTE - START/STOP/OPEN/CLOSE CONTROL

All control functions shall utilize the select-check-back-execute control sequence and digital output sub-system of field stations shall recognize two commands associated with device control.

After point selection and control action have been verified, the software shall initiate a select-check back-execute control sequence with the selected field station PLC/ RTU/ Local Control and independent of the initiating select procedure. When the control action is initiated, the software shall set a flag showing that a device change-of-state is expected. Failure to receive a status change within a predefined period shall show a faulty control action and initiate an alarm at the Master Control Station.

5.23 SUPERVISORY CONTROL FUNCTIONS

Supervisory control functions shall comprise of multi-step interactive procedures to avoid accidental operation of plant equipment.

These interactive procedures to be supported shall include:

- Start/stop/close/open control
- Set-point control
- Sequential control

The SCADA system shall lead the operator through all of the correct steps necessary to successfully operate the selected device and minimize the chances of incorrect operation.

5.24 START/ STOP/ OPEN/ CLOSE CONTROL

This control function shall be used to control multiple state devices in the pipeline system and the SCADA system. All these control functions shall utilize the select-check back-execute control sequence and Digital output sub-system of PLCs shall recognize two commands associated with device control.

The following procedure shall be used for open/close control of a device;

- **Execute the control function:** The colour of the symbol for the designated device on the display shall be changed to indicate the selected status. The selected device and the required control function shall be identified on a dialogue line together with the control blocked or inhibit status of the device. This step shall be time-supervised. If the control request in the next step of the dialogue is not made within a defined; period, then the device selection shall be automatically cancelled and the dialogue line cleared/. In this sequence, the permissive shall be checked.
- **Execute the open or close function:** If the control request is valid, the device status shall be changed and the dialogue line cleared. If the control request is not valid, the selection of the device shall be cancelled and an error message displayed in the operator message line.

The control request shall be processed as an event.

5.25 SET POINT CONTROL

The set point control function shall be used to provide a set point for analogue control equipment.

The set point changes shall require two execution steps. The first step is to change the analogue output to desired value. The second step is to generate a Gate signal (Digital output to the analogue control equipment to indicate that a new set point value is to be read. The actions required to perform the above steps shall be as follows:

- Select a display which shows the required device. Position the cursor to the required device
- The operator shall verify that the correct point has been selected enter the new set point value and issue `select for control' command. This command shall be routed to the PLC. A selection verification message shall be generated by the PLC and which will be displayed and logged at Master Stations.
- After `select for control' command, the operator shall issue a `control after select' command which shall cause the PLC to route the selected set point value to analog control equipment through analog output sub-system and to generate an event message which shall be sent to Master Stations for display and logging. Any command other than `control after select' shall cause the PLC to cancel the selection. Further, if the `control after select' is not received within a predefined period, the PLC shall automatically reset the circuit canceling the selection.
- The operator shall issue Gate digital output command associated with the set point he is changing by utilizing the select-check back-execute control sequence. When the Gate digital output changes state, the set point shall be downloaded to the controller and an event message shall be generated by the PLC for display and logging at Master Stations.
- A point for control command shall be selected provided the device is in remote control mode, else system shall generate the appropriate message.

5.26 SEQUENTIAL CONTROL

The sequential control function shall initiate the execution of previously defined sequence of control commands. Its implementation shall minimize the chance of incorrect operation of plant and consequent danger or damage.

In addition to control commands, the sequential control function shall be able to include safety checks and delays.

The following procedure shall be used to initiate a sequential control which is associated with a device or a number of devices on a display:

- Select a display showing the required device
- Position the cursor to the required device
- Execute the sequential function. The color of the symbol for the designated device on the display shall be changed to indicate the selected status. The selected device and the sequential control mode shall be identified on the dialogue line. This step is time-supervised. If the next step of the dialogue is not made within a predefined period, then the device selection shall be automatically cancelled and the dialogue line is cleared.
- Execute the start (on) sequence or stop (off) sequence function. Two different sequential controls can be defined for the same device, one of which is initiated with the start (on) function and the other with the stop (off) function.

The Cancel function shall interrupt a sequential control in progress, at the completion of the current step in the sequence. In this case, the device selection shall be cancelled and the dialogue line cleared.

The following additional execution control functions shall be available during the sequential control execution:

- Suspend execution
- Resume execution
- Step execution

A listing of the sequence shall be displayed during its execution (if relevant) in which case an indicator shall show the currently executing step in the sequence.

When the sequential control is completed, the device selection shall be cancelled and the dialogue line cleared.

The initiation and completion of a sequential control are processed as events. The individual commands in the sequence shall be processed as events if this is defined.

5.27 LOCAL CONTROL

All equipment shall be provided with the means to operate the equipment locally in LOCAL mode. Such control may be at the device itself or at the associated MCC or local panel. Local control shall be fully independent of PLC control, and is activated by placing the Local-Off-Remote switch in the LOCAL position. Indication of the position of all LOR switches shall be provided, as required on the SCADA System HMI.

5.28 TIME SYNCHRINIZATION

The primary workstation of the SCADA system shall be the `Master Clock' for the overall system Date and Time Facility. The PLCs should be synchronized with the master clock. Whenever the SCADA workstation Date and Time is set or reset, an automatic synchronizing signal shall be transmitted by telemetry to all PLCs. Any PLC subject to a `Telemetry Failure' shall automatically be sent a synchronization signal on restoration of telemetry.

PLC time synchronization shall be done w.r.t. SCADA system primary workstation periodically with the time interval as system definable parameter. The PLC internal circuitry shall compensate for the delay due to message structure, transmission delay and baud rate to arrive at the correctly matching time. Positive acknowledgement for the time synchronization shall be sent by the PLC.

Should there be a discrepancy between time at a remote station and the time received from SCADA workstation by telemetered synchronization signal, then the remote station local intelligence shall automatically re-set and synchronize local time with SCADA workstation time within resolution of 10 msec. This synchronization shall be recorded as an EVENT and printed out.

All the nodes on the dual LAN, at the Master Stations shall be synchronized with the master clock every one minute permitting maximum 10 msec time difference.

5.29 HMI TRENDING

Variables such as flow, level, temperature, speed, and measurements from analytical instruments shall be able to be trended both in real-time and historically. An Operator should have the ability to call up real-time or historical trends that display interdependencies between process variables.

5.30 HISTORICAL STORAGE

A historical data storage and retrieval system capable of holding a minimum of 5 years of data on-line without requiring installation of archived media shall be provided.

Time-tagged events and analog variables shall be stored in memory and on a storage facility at the control centre level. Historical storage parameters for each variable such as on/off storage or periodicity of storage shall be defined in the Database and shall be modifiable on-line. All the needed information for operating statistics shall be stored and processed in the event of a long shutdown of the computer or a change in any database with no effect on the variables in question.

The historical retrieval function shall include as a minimum:

- a search for data prior or subsequent to a date or event or type of event,
- statistics or periodical log printout functions,
- storage or printout of the results of search, functions and statistical processing,

5.31 MODIFICATION OF OPERATING PARAMETERS

All operating parameters shall be modifiable by the operator. Operating parameters shall be for example:

- thresholds for alarm generation,
- thresholds for start-up and stop the units,
- category of events for Event Log functions,
- operating constraints.

5.32 MODIFICATION OF SOFTWARE

It shall be possible to add, delete or modify any variable in the database on-line with no disturbance in the real-time running of the programs.

For all the equipment, such modifications shall be made on the Engineer Station. Access to this function shall be protected by an easy-to-use password. It shall be possible to display all the attributes of a variable on the screen at the same time, and modifying them shall require no knowledge of their physical location or their computer code.

Each modification event shall be dated and memorized in a file.

5.33 INTEGRATION SUPPORT

SCADA system shall support integration of multiple vendor PLCs, based on latest technology and widely used IEC protocols and the system shall be able to communicate with multi-vendor PLCs and dependency on the supplier proprietary firmware etc. shall be eliminated.

5.34 ACCESS CONTROL

The system shall have extensive features to prevent unauthorised access to the system. It shall also have a user log to record data regarding usage of the system.

Pass Word security shall be provided for access to the system and its applications. It shall permit only authorized users to access a system through the consoles. Users shall log in by entering a user ID and a PW. Each PW shall be validated against the corresponding user information in the database. A successful log-on operation shall the user access.

A procedure shall be provided for users to log on and log off. Each log-on and log-off shall be reported as an event. The event message shall indicate the date and time the procedure was executed, the name of the console and identification of the user.

A secure method shall be provided for the designated authority to establish and change pass words and user identifications. System pass words shall be stored in encrypted form. Users shall have the ability to change their own pass words.. it shall be done via a single entry sequence and propagated to all authorized system applications and processors.

5.35 INSTRUMENTATION FAULTS

The SCADA system shall have the ability to identify and react to malfunctioning instrumentation. Input signals that are abnormal or out of range should be alarmed. In addition, the SCADA system must be capable of modifying or inhibiting control when signals assume abnormal or out of range values. Equipment control must be automatically placed in a fail safe mode upon instrument failure.

5.36 EQUIPMENT FAULT MONITORING

Any time field equipment fails to respond to commands, changes status without Operator or strategy intervention or switches states, the SCADA system shall notify Operations via an alarm.

5.37 REPORT GENERATION

The system shall have the facility to generate reports on a fixed schedule as well support ad-hoc reporting to suit the operational requirement. The reports shall contain both real time and historical data.

Support shall be provided to print data from the database for record purposes on designated hardcopy report printers. Command procedures for data sorting etc. shall be provided. All data in the database shall be available for reports including tele-metered data, applications data, time-tagged data, calculated data, and planning data. The MMI shall provide facilities for report scheduling and control.

5.38 INFORMATION FOR MAINTENANCE AND STATISTICS

In addition to the functions described in the document, the SCADA system shall perform all necessary functions for a convenient operation and maintenance of the water supply facilities, and needed for statistics. The contractor shall provide the complete details of these functions at the detailing stage.

5.39 SYSTEM DIAGNOSTICS TEST FACILITIES

The SCADA system shall have self-diagnostic functions running on-line and able to detect any failure of hardware or software. Comprehensive test facilities and self diagnostic routines shall be provided to facilitate full functional testing of all subsystem including the modules for workstations, PLCs, etc. Comprehensive diagnostics and the test facility for each sub-system shall be an integral part of the SCADA system.

5.40 FUNCTIONS AT THE FIELD LEVEL

The states, positions, failures of all the elements controlled from the PLC level shall be acquired individually by the PLC and transmitted to the Control Centre.

The local control level shall include the following equipment:

a) Programmable Controller (PLC) with local control panel with its commands and display of measurements and signals

b) Input/ Output Modules

c) Interposing and other relays

d) Terminal boards

e) Measurement devices

f) Maintenance devises

Among the information processed by the PLC, some items shall generate alarms and shall be parameterized in the database as "major alarms", "normal alarms", or "minor alarms" on the appearance of an alarm datum, the field station :

- shall generate the alarm and store the event in memory,
- shall transmit the alarm to the Control Centre for logging functions,

- alarm processing function on the Human-Machine-Interface,

6.0 SCADA HARDWARE

6.1 GENERAL

The requirements specified in this document are to establish a baseline for the type of equipment required. Due to rapidly evolving technology of the equipment specified, the Contractor shall supply the latest hardware and software of similar specification at the time of purchase equivalent in cost to that which is specified.

The Contractor shall submit for approval the required data for each equipment as part of the Hardware submittal. The equipment shall be ordered as late as possible depending on the construction schedule to ensure the latest equipment available is provided. Just prior to ordering, the Contractor shall resubmit for approval the required data of the latest available hardware and software equivalent in cost to that which is specified. No equipment shall be ordered more than 3 months prior to when it is needed to be continuously used on the project.

6.2 WARRANTY

The Contractor shall provide next day manufacturer on-site service for all computer system hardware devices covering parts and labour for two years from date of Substantial Completion. The on-site service is to be performed by an authorized representative of the manufacture of the installed servers.

6.3 EQUIPMENT

The local SCADA Control Station shall broadly comprise of the following equipment:

a) One SCADA Server with all necessary accessories and software.

b) Two PC based Operator Workstations, each with two sets of 20 inch TFT color monitors, printers and all necessary accessories and software.

c) One portable engineering station with one color printer and all necessary accessories and software.

d) Control desks for operator work stations, engineering station, Data Storage system.

e) Four chairs with bending mechanism, sitting height adjustment and ergonomic adjustment.

f) One set of router/gateway/ networking equipment for communication with SCADA Master Control Station at Command & Control Centre of the project.

6.4 SCADA SERVER

The server shall be server class computer set-up to run HMI and Historical server software with Dual Xeon Processor, Intel 2.4 GHZ each processor, adequate main and auxiliary memory, storage media, optical drives, Dual TFT colour monitor, 20 inch, 4:3 aspect ratio, Video card, On-Board Dual Network Adapter, USB Key board and mouse, etc. The server shall include the SCADA Software with facilities for data processing, memory units and communication interfaces.

All servers to be provided with Dual 10/100/1000Mbps Ethernet ports, One hot pluggable port for external Cartridge magnetic tape drive TPC/ Spec mark performance compliance redundant power supply, redundant fan.

Operating system: Windows Server, latest edition supported by the software manufacturer.

Other Software like,

- Microsoft Office Professional (Latest Edition) shall include the following programs as a minimum
    - Microsoft Excel
    - Microsoft Word
    - Microsoft Access
    - Microsoft PowerPoint
- Adobe Acrobat Professional (Latest Edition)
- Microsoft Internet Explorer (Latest Edition compatible with installed software)
- WinZip Professional (Latest Edition)

6.5 OPERATOR WORKSTATIONS

The operator Workstation console shall be used as a Human Machine Interface (HMI) for interacting with all SCADA systems. Operator Workstation consoles shall also be used as development console to take up developmental/ maintenance activities such as generation/updating of database, displays etc.

The operator consoles shall assist the operator for an easy operation and control of the facility, shall allow print out and provide displays of all relevant signals, events, alarms, status, status changes, abnormalities, history data on request or immediately in case of alarm. The work stations shall be latest high end based on latest version of Windows Networking operating system. The operator stations shall be configured so that in case of failure of one operator station, the other station shall automatically take over the control of the failed one without any operator intervention. The changeover shall be smooth and rapid without affecting the system that is being controlled. All functions shall be accessible through the monitor and keyboards/mouse.

The minimum hardware configuration of operator work station shall be Dual Quad Processor, Intel 2.4 GHz and above, adequate main and auxiliary memory, Internal DVD R/W drive, Dual TFT coloured Monitors (VDU) 20-inch 4:3 aspect ratio, Video Card, network interface, USB Keyboard, USB laser mouse with scroll wheel, etc. internal Chassis speaker.

Operating system: Windows Server, latest edition supported by the software manufacturer.

Other Software like,

- Microsoft Office Professional (Latest Edition) shall include the following programs as a minimum
    - Microsoft Excel
    - Microsoft Word
    - Microsoft Access

- Microsoft PowerPoint

- Adobe Acrobat Professional (Latest Edition)
- Microsoft Internet Explorer (Latest Edition compatible with installed software)
- WinZip Professional (Latest Edition)

The operator desks, to be supplied by the Contractor, shall be provided with all accessories, telephone desk-type, power socket outlets, provision for public address system installation etc.

6.6 PORTABLE ENGINEERING STATIONS

Each portable engineering workstations with all features and accessories check the status and loaded with all software & system configuration settings similar to that of Operator Workstations. Fixed engineering station necessary for the purpose, shall be included in the scope of the supply.

These stations shall have the following features including software for:

- Reprogramming
- Process simulation
- Engineering calculation
- Program testing
- Documentation,
- Low level expert system tester
- Training functions.

Software and programming tools provided shall allow creation of all mimic views to be displayed. From this desk, it shall be possible to follow the control and operation and to execute trouble shooting, reprogramming, parameter and set point changes and all necessary work to support and maintain the system. The stations shall be installed on separate desks in the control room and connected to the control room network. Each desk shall have separate monitor, keyboard, mouse and other necessary accessories.

6.7 COLOR GRAPHICS TFT MONITOR

Each colour VDU shall be industry grade, field proven, designed for 24 hours trouble-free operation, with easily replaceable modules. It shall essentially consist of low radiation, high resolution monitor and display controller. The monitor shall be specified size, colour, Monitor, suitable with controls for contrast, brightness and power. The display shall be stable, flicker free, with good contrast, without distortion and without glare and reflection

6.8 KEY BOARD AND MOUSE

Operator's keyboard shall provide operator interface for control and display functions in conjunction with the monitor.

The following minimum design features shall be provided :

a) Alphanumeric key board and numeric keyboard for data entry.

b) Key-lock switch control over critical system functions.

c) Page and cursor control keys and mouse/track ball.

d) Pre-defined function push buttons for various functions according to the type of key board.

e) Alarm acknowledge and cancel push buttons.

f) Hooter for audio annunciation.

g) Extensive error checking and error messages on user entries.

6.9 CONSOLES

Console Desk shall be provided for operator's HMI, providing work surface, lockable drawers, internal power distribution, internal fitting arrangements for monitor, with all storage and peripheral devices.

6.10 INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted that the dedicated communication links between SCADA Master Control Station at the Command & Control Centre and Water Supply Local Control Stations/ Programmable Logic Controllers (PLCs)/ Remote Terminal Units (RTUs)/ field devices shall be Fibre Optics Cables/ GSM Communication Network/ Radio Communication. These Communication links is the responsibility of the Employer and is therefore excluded from the scope of work of the Contractor. However, the scope of work of the contractor under this contract covers integration of the complete Water Supply Instrumentation, Automation and SCADA system with the SCADA Master Control Station (s). The contractor shall have to co-ordinate with the other contractors in order to provide a fully functional SCADA system

7.0 PROGRAMMABLE LOGIC CONTROLLERS

7.1 GENERAL

This Specification covers the scope and technical requirements of the Programmable Logic Controllers.

PLC shall acquire data from the field devices, communicate with the control centre, execute control commands and perform all control functions.

The controller shall be supplied with the CPU, input/output scanner, inputs, outputs, memory, power supply, and all power and interface cables necessary to function as a complete and operable PLC system. Complete integration of control and automation system with PLC's including integrated performance guarantee is under the scope of the successful contractor.

All PLC units used shall be of the same manufacturer and of the same model and shall consist of equipment models that are currently in production. Interchangeability and interoperability of PLCs used shall be established by the Contractor.

7.2 SCOPE OF SUPPLY

The supply for PLC shall include all equipment and services for operation and maintenance, such as manufacturer's standard firmware, licensed PLC programming and debugging tools, test equipment, all software with license for use and source codes for the application programs, spare parts and full documentation along with training.

The system shall be delivered completely programmed for the complete and reliable operation of the plant.

All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient documentation and program listing so that it is possible for the Purchaser to carry out modification at a later date.

The PLC system shall be provided with necessary interface hardware and software for interfacing with Fibre Optics/Other communication network/ GSM/Radio Communication for two-way transfer of signals with the control centre. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering.

All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be supplied and installed per the manufacturer recommendations.

7.3 GENERAL DESIGN REQUIREMENTS

a) The PLC shall be of modular in architecture, microprocessor design with interchangeability provided for all similar I/O modules and has capability for future expansion by the addition of required hardware and revision of user software.

b) The PLC shall be designed for high reliability, ease of maintenance and designed for continuous service in the harsh industrial environments prevailing at site.

c) The PLC shall be configured such that interdependence of functions is minimised and failure of any part of a PLC subsystem shall not directly affect the integrity of the unit, as a whole.

d) The PLC shall be designed and tested to operate in a highly electrical noisy environment and comply with IEC 60801 for electromagnetic compatibility.

e) All equipment shall be designed and constructed so that in the event of power interruption there shall be no loss of memory, and the equipment shall resume normal operation without manually resetting when power is restored.

f) All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling without the use of an internal fan.

g) The PLC shall support data access by a third-party server using Modbus or OPC. **Communication with control system -** The PLC's shall report the status of its input/output points to and accept control from a third-party System using OPC, Modbus or any other protocol. Where supported by the protocol, the PLC shall use report by exception to reduce network traffic.

h) All power supply cards, I/O module connections and other external interfaces shall be provided with suitable surge protection devices to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard.

7.4 PLC FUNCTIONS/FEATURES

The PLC processor unit shall be capable of executing the following functions:-

a) Receiving binary and analog signals from the field and operator initiated commands from control centre.
b) Implementing all logic functions for control, protection and annunciation of the equipment and systems.
c) Implementing modulating control function for certain applications as specified in the specification.
d) Issuing control commands.
e) Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
f) Performing self-monitoring and diagnostic functions and reporting failures to the control centre. Each controller shall have built-in functions of on-line self diagnostics / watch dog features etc and shall report failures to the operators of the control system.
g) Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI). The PLC shall be capable of stand-alone operation in the event of failure of the communication link with the HMI subsystem.
h) Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

7.5 EQUIPMENT AND COMPONENTS

The PLC shall comprise of a central processing unit, input and output modules (digital and analog), communication/networking modules, voltage surge protection units, signal converters, isolators, power supply units, programming tools and other equipment necessary to form a complete working system.

The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future.

7.5.1 Processor Unit

The unit PLC equipment shall have adequate memory for functional capacity to perform the specified sequence of operation with the scheduled input and output points. The processor shall be provided with maximum available memory for logic programming storage, including on-board CPU memory and provision of available separate memory card modules. The user program and data shall be contained in non-volatile battery backed memory.

The processor unit shall, in addition to performing normal control functions in accordance with the program, monitor the status of its own operation as self- diagnostic and initiate present logic shutdown sequence in the event of system malfunction. Clear visual indication on the health status of the unit shall be provided.

7.5.2 PLC Processor Redundancy

A redundant processor unit complete with power supply shall be provided to form a hot standby system with bump-less transfer of control operation without causing any disturbance whatsoever. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. To facilitate maintenance, manual switch over to the standby processor unit shall be effected by a key switch or through the programming tools.

The processor unit shall be capable for future expansion of input/output modules up to 30% without major modification or upgrading work being required. The capability of upgrading to better performance processor with higher speed and enhanced functionality with no change of the control program is desirable.

The processing unit shall be chosen such that, with the complete application program running, the response times shall be better than 0.5 second for digital I/O points and 1 second for analog I/O points

7.5.3 Programming Tools

A set of user-friendly PLC programming software shall be provided as programming tools. The software shall be installed on a conventional notebook computer and capable of programming all types of processor units installed with the full set of processor supported instructions. This programming software shall allow editing and testing of application programs in formats that comply with the general standard specification.

The minimum requirements of the PLC programming software shall include routines for entering and editing programs; monitoring the status of the control programs; storing, duplicating and printing programs; cross referencing the register and I/O addresses; and controlling the states of the processor including diagnostic functions. The PLC programming software shall be capable of downloading / uploading control logic programs to the processor unit and incorporate fault diagnostic and export function enabling data manipulation and printing of the processor control program, register contents and cross-referencing of address.

7.5.4 Power Supply System

The power supply system shall have its output isolated from the mains input and be floating with respect to the mains earth. The power supply shall be protected against short circuits and power surge, and the power supply module of PLC shall contain its own over current and overvoltage protection

The normal power supply to the system shall be 230V 50Hz or 24V DC. PLC systems operating on AC supply shall be powered from uninterruptible power supply (UPS) equipment. The Contractor shall provide detailed power consumption requirements to the Employer to determine the rating of the UPS equipment.

All power supply cards, I/O module connections and other external interfaces shall be provided with suitable surge protection devices to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard. Degree of protection shall be minimum NEMA 1 (IP20) . Each PLC shall have long-life internal battery backup/ non-volatile memory for storing running data and programs. All software and firmware supplied must be of latest release/ version.

7.6 COMMUNICATION WITH SCADA CONTROL CENTRE

Communications with other intelligent devices such as SCADA Control Systems shall be able to be carried over various media such as fibre optics, GSM, radio, microwave, leased or dial up telephone lines, mobile telephone and IP network

The PLC shall report the status of its input/output points to and accept control from a third-party SCADA or Distributed Control System using OPC, Modbus or any other protocol as specified. The

PLC system shall be provided with necessary interface hardware and software for dual fibre optic connectivity & interconnection with station wide LAN for two-way transfer of signals for the purpose of information sharing. The plant information shall be made available through an OPC compliant Ethernet link following TCP/IP standard. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering.

Two (2) Nos latest version of PC based Operator Work Stations each with 20" colour TFT's and key boards shall be provided for control & monitoring and programming function. One no. number heavy duty A3 size colour inkjet printer shall be provided along with operator work station. These work stations shall perform control, monitoring and operation of all auxiliaries/drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC.

8.0 SYSTEM INPUT / OUTPUT MODULES

8.1 GENERAL

Each PLC shall be supplied with requisite number of I/O cards in standard rack mounted modules with plug-in boards.

All Input/Output modules shall meet the following general requirements :

a) Standard rack-mounted I/O modules with plug-in boards shall be provided.
b) All necessary input/output interfacing equipment required for signal processing shall be provided.
c) In order to provide flexibility of arrangement and to economize on hardware, all digital and analog I/O cards shall be physically interchangeable within the I/O card frame. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off power supply.
d) Cards shall be labeled with module description to identify specific types of input cards from output cards.
e) Upon final selection and arrangement of I/O cards, the option shall be available to 'key' the card receptacles in the I/O structure to prevent future incorrect placement of I/O cards. Where physical keying is not available, the PLC shall have logic to prohibit processor running and produce fault indication on the processor module on detection of incorrect I/O placement.
f) A fault occurring on an input/output point shall not affect the operation of any other circuits. Removal/insertion of an input/output card shall not cause damage to a running PLC, otherwise interlock mechanisms shall be provided to prevent inadvertent removal/insertion of an input/output card until power is switched off.
g) The input/output cards shall be so allocated as to ensure a minimum number of equipment to be affected when a card is removed.
h) The number of input/output signals handled by a card shall not exceed 16.
i) Wiring to I/O module terminals or harness shall be at least 0.5mm^2.
j) Illuminated push button panels integral with input/output modules shall not be used unless prior approval has been obtained
k) Each I/O point shall be furnished with

- Indication for On/Off state of the field device.
- Protective network, such as surge protections, optical coupling and/or other isolating

barriers

- Filter for noise reduction,
- Indication for module's communication status/ fault
- indicationTest points and fault indication
- lampsFuse protection and fuse failure detection

l) Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.

m) Modules shall have indicators to display the status of communication, module health and input / output devices.

n) The possibility of isolating faulty channels.

8.2 DIGITAL INPUT MODULES

The digital input (DI) modules shall be provided for the periodic scanning of digital inputs.

a) All inputs shall be protected by optical isolators. Any changes of state in the digital inputs shall be reported to the main processing module for further processing.

b) Status changes shall be time tagged to tag the time of input event with one millisecond accuracy.

c) Filtering shall be provided to protect against contact bounce or electrical noise on input lines.

8.3 DIGITAL OUTPUT MODULES

a) Digital output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays, etc. without any extra hardware. In the case of driving an actuator an interposing relay with adequately rated contacts or contactor shall be used for the interface.
b) All outputs shall be protected.
c) Contact bounce protection shall be provided.

8.4 ANALOG INPUT MODULES

Analog input modules shall convert an analog signal that is connected to the module's terminals into a digital value. All inputs shall be protected by optical isolators

Analog input shall be 4-20mA d.c. The analog inputs shall be multiplexed into a floating differential input analog-to-digital converter with inputs buffered and filtered to reduce mains noise. The accuracy shall be better than 0.5% over the entire operating temperature range.

The A/D converter shall have the following characteristics :

- better than or equal to 12 bits resolution,
- full range accuracy better than ± 0.1 %, over the operating temperature range,
- common mode rejection ratio more than or equal to 100 dB/ 50 Hz,
- serial mode rejection ratio more than or equal to 60 dB/ 50 Hz,
- inputs scanned and updated more than or equal to 4 (four) times per second,

To eliminate problems caused by common earth, the inputs shall be isolated from chassis ground

and internal electric ground. The isolation shall be able to protect against a minimum of 400V and a transient of 1500V. The inputs shall be protected against high induced or pick-up voltages.

8.5 ANALOG OUTPUT MODULES

Some of the common features of the I/O modules shall be as follows:

i) All inputs shall be terminated with input protective network and necessary isolating barriers.
ii) Filters for noise rejection.
iii) Provision for isolation of faulty channels.
iv) Test points and fault indication LEDs shall be provided to carry out module testing.
v) Surge withstanding facility as per IEEE standards.
vi) All the modules shall be of addressable type.
vii) Protection for continuous overload up to 200% of all input ranges.
viii) Fuse protection and fuse failure detection.
ix) Internal battery backup.
a) Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals
b) The D/A-converter shall have the following characteristics:

- better than or equal to 12 bits resolution, full range,
- full range accuracy better than ± 0.5%, over the operating temperature range,
- characteristics ± 1/2 LSB (Least Significant Bit) repeatability,
- ± 1 LSB linearity,
- common mode rejection ratio more or equal to 100 dB/ 50 Hz,
- differential mode rejection ratio more or equal to 60 dB/ 50 Hz.

Technical Particulars

1	Service	As per process
2	Functions	As per the control logic and Input/ Output lists for PLC
3	Software	To perform all the functions mentioned in the control logic and write-up
4	Expandability	20% of installed capacity
5	Interposing relays	Shall be provided for all the digital outputs (DO) including spare DO and for digital inputs wherever required.
6	Optical isolation for all digital inputs and outputs and galvanic isolation for analog inputs	Required
7	Processor Diagnostic function performance Minimum 16 bit performance with floating point capability performance Minimum 16 bit performance with floating point capability Memory module	Required Required To store programs, standard software to perform logic functions and diagnostic functions
8	Mounting	Inside the instrument control panel (ICP)
9	Inputs and outputs	As per I/O list
10	System loading	Max. 60% under worst loading conditions.
11	Type of input	NO/NC – contacts field selectable

12	Output	Relay outputs for driving MCC starter coils, motorised valves etc.
13	Spare I/Os	20% of each type, wired to terminal block.
14	Accessories	Programming software to be loaded in Purchaser's PC along with communication cable.

The digital input & digital output modules shall not have more than 16 channels in each module. The analog input modules shall not have more than 8 channels in each module.

8.6 INPUT / OUTPUT LIST

a) The Input/ Output modules shall be equipped to handle the I/O point requirements for each field station as described in Appendix - 1 (two files). The I/O list provided gives an indicative assessment of the total number of I/O's of each type required for the project. The actual number of I/O's may vary at the detailed engineering stage. The contractor shall provide the I/O modules based on the final I/O list prepared in consultation with the Employer, keeping in view the system functional requirements.

b) All I/O channels provided (used as well as additional / spares) irrespective of immediate application shall be wired from I/O module along with all required accessories and cables to the associated panel/cabinet with proper segregation and identification of Digital inputs and Digital outputs.

c) The contractor shall also keep an allowance of approximately 20 % active spare I/O points over and above the calculated I/O's by providing space for adding cards and terminations in future.

9.0 HUMAN MACHINE INTERFACE (HMI)

9.1 Features

Human Machine Interface shall facilitate dialogue between the operator and the system. It is critical to the operation of the SCADA system and the Contractor shall provide a secure, flexible and `User-Friendly' interface by which engineers, supervisors and the operators may interact with the system and pipeline network by way of the computing equipment, database and software.

The graphic displays shall be windowed, fully supported with appropriate graphics and symbolic diagrams. All procedures shall be selectable by menu and context sensitive help displays shall be available.

The HMI system shall be fully integrated with database system
The operating system shall have proven industrial standard for high performance Graphical User Interface (GUI) and Application Programming Interface (API).
The database with complete record of telemetry points with static, dynamic and configuration parameters shall be resident in all the computer workstation.
The configuration changes made in the database files will be automatically updated on all the workstations.
Every display request and manual input shall be acknowledged by the system with a direct and positive response that indicates if the entry has been accepted or not, for each step of multi-step procedure messages on the monitor shall be used to prompt the operator for the next expected entry.

9.2 Functions of the Human-Machine-Interface

The following list shall constitute the minimum set of operating functions and their corresponding operator dialogue functions:

- Supervision and control of the complete Water supply system.
- Supervision and control of the other distant sites equipment,
- Supervision of the SCADA system,
- Processing of alarms and (data) messages,
- Processing of remote data and parameters,
- Obtaining information on the status and changes in status of the operation and the system,

9.3 Organization of the Human-Machine-Interface

The Contractor shall supply all the equipment needed to implement the dialogue functions described above, taking into account the need for visualization in normal operation. Where workstations are each supplied with multiple screens, the intervention of more than one operator shall be possible with no disturbance to normal operation. In such cases the associated pointing device (trackball or mouse) and keyboard shall be shared between the multiple screens. The screens shall be aligned on the same level and the cursor associated with the pointing device shall be capable of passing from one to the other without interruption. The cursor shall only be assigned to one screen at once (called active screen). An icon displayed on the active screen shall allow the operator to designate by clicking on it to order the active screen to be changed.

9.4 Alarms

Alarms are conditions that require user notification when detected. All alarms shall be presented to the user in a consistent manner.

Alarm conditions shall include, but not limited to, the following :

a) Telemetered or calculated value

b) Values returning to normal from a limit violation state

c) Uncommanded changes of a device state

d) Certain application program results

e) Hardware and/ or software failure.

Each alarm shall be subjected to a series of alarm processing functions.

9.5 Alarm Detection

Alarm monitoring shall be done for process variables, equipment malfunctions and control deviations.

Operating limits, viz., high limit, low limit or both high and low limits shall be assigned to specify analog inputs and calculated variables. The system shall check for violation of these limits to detect alarm conditions. Provision shall be made for variable alarm limits also.

In addition to the above operating limits, specified variables shall be assigned for specification viz., high-high limit, low-low limit or both high-high and low-low limits.

One of the states (0 or 1) of all digital inputs shall be designated as the alarm state. Status change for digital inputs shall be checked at each scan.

Return to normal state from alarm condition shall also be detected. For analog variables dead-band feature shall be provided to avoid cyclic alarms. Points oscillating around threshold shall be automatically blocked from coming as alarms, more than a certain number of times.

Provision shall be made to clarify alarms into major and minor categories.

9.6 Alarm Monitoring Guidelines

The following are general guidelines for selection of alarms to be monitored by the control system :

- The PLCs will generate alarm signals for all equipment status changes, process parameter values crossing high/low threshold limits, excessive rates of change, controlled device failure to respond and system diagnostic signals.
- All emergency or alarm conditions shall be reported to PLC panel as well as transmitted to the control centre for operator acknowledgement and response as determined by the alarm priority.
- Each alarm will be assigned a priority reflecting its severity and importance. All critical alarms requiring immediate action will generate a specific alarm annunciation with an audible alarm at the control centre. Other alarms that are not critical shall also generate audible alarm that can be distinguishable from the critical alarms. The operator at the control centre shall be able to acknowledge these alarms.
- Alert signals not requiring immediate operator attention will not generate audible alarm.

9.7 Alarm Acknowledgement

An alarm shall be acknowledged by selecting an alarm acknowledge command when the item in alarm is selected on :

a) Any display showing the item in alarm

b) Any display showing the alarm message.

It shall be possible to acknowledge alarms individually. When an alarm is acknowledged, blinking of the alarm condition on displays and console visual indicators shall stop and the audible alarm turned off. The console alarm lamps shall be turned off when all alarms in the categories assigned to that console have been acknowledged.

10.0 SCADA SOFTWARE

10.1 SOFTWARE REQUIREMENTS

The contractor shall provide all software, along with necessary licenses, required for performing intended functions in an efficient manner. The source codes of project specific application software shall be the property of the Employer.

The software shall be modular in structure, facilitating changes and extensions of the system. In particular, it shall be possible to modify any module with minimum changes in other modules, and to upgrade peripherals and human-machine units in the future with no extensive rewriting of the software.

Complete documentation including program listings in source language for application and customized application software shall be provided. All documentation and computer print-outs shall be in English only.

10.2 SOFTWARE STRUCTURE

THE SOFTWARE SHALL BE FIELD PROVEN IN SIMILAR TYPE OF APPLICATION. AS A MINIMUM REQUIREMENT, THIS SHALL COVER THE FOLLOWING:

- System and Database configuration
- Generation of current raw & processed telemetered database.
- Generation of historic data for trending and archival.
- Alarm handling, including storage, display and printout
- Generation, storage, presentation of mimic diagrams with dynamic information presentation on screen.
- Display management for alarm alerts, mimic diagrams analog and digital values, trend graphs, bar charts in semi-graphic and high-resolution colour graphic modes.
- Free format report generation, storage and printout.
- Data logging at periodic intervals, on operator request and automatically on occurrence of an event.
- Redundancy, workstation determination, fail-overs and recovery processes
- Database synchronisation with processes

10.3 SYSTEM SOFTWARE

The operating system shall be latest Windows based network operating system available at the time of supply. All Servers shall also be based on latest Enterprise edition of windows based Server operating system available at the time of supply. The system shall be designed to allocate resources to tasks in a real-time environment. Resources may be memory, input/output peripherals or communication. The Real Time Operating System supplied shall be proven for similar applications and shall be able to support all the equipment/peripherals.

It shall have the following minimum features :

- Multiprogramming, Multithreading and Multitasking facility including background and foreground operations in real time mode.
- Real time capabilities
- Dynamic Memory allocation
- System Security Features
- Real time Programming and Processing
- Support disk mirroring
- Line and Page editors, library management

- Real time database management
- RDBMS/SQL database management
- Dual LAN support
- OSI/TCP/IP network connectivity support
- Graphic support packages

10.4 CUSTOMIZED APPLICATION SOFTWARE

The application software provided by the Contractor shall have been tested and commissioned successfully in the field. The Contractor shall supply a copy of the source program, listings and descriptions, and shall clearly indicate any restrictions, special conditions. It is essential that the Employer shall be able to modify all the application software himself without calling the Contractor.

The customized application software components shall include at least the data base, the graphic picture editor, report compiler and human machine interface. Widely proven software products shall be used to meet the system requirements. All operating parameters shall be modifiable by the operator and necessary interfaces /mimic views/ forms shall be provided for assigning set points with respect various parameters, assigning unit priorities, and giving direct orders/commands to the system.

All software shall be licensed with no licensing restrictions on the number of connected HMI clients. The software shall be licensed to provide an unlimited number of graphic displays and to allow an unlimited number of operator logins available.

11.0 SCADA NETWORK TOPOLOGY

SCADA systems transfer real-time critical data and require robust, reliable communications for PLC to PLC, server to PLC, and server to workstation data exchanges. Communications media to convey signals between network devices shall be fibre optic cables, radio communication and copper cables. Fibre-optic cabling shall be installed for all backbone network segments that run between various process areas of the projects and between buildings. Copper cabling may be used for network segments that are completely within a single room, such as a control room, and between fibre optic network nodes and devices such as PLCs, subject to the maximum allowed distance for such applications. In order to ensure performance of critical data communications between PLCs and other nodes, the SCADA System will be implemented with Ethernet networks. For each network installation the topology shall be evaluated as part of the design. The topology for the SCADA Network shall be a star configuration at 100Mbps. For the PLC Network, the preferred topology shall be a star configuration. However a ring configuration or hybrid star-ring configuration may be used if facility layout makes a star topology impractical or too expensive. The configurations shall need to be evaluated and the best design identified. It shall be ensured that in each case a level of redundancy that ensures system reliability is achieved.

11.1 PLC Network Topology

The PLC Network shall provide 10 Mbps Ethernet communications between PLCs, SCADA nodes and the programming terminal. The topology will be a star topology. Fibre optic cables

will extend from the PLC Network Ethernet switch to selected locations within the facility.

For the PLCs, a dual channel fibre optic ring will connect the PLCs. The two channels, operating over separate fibres, will communicate in opposite directions around the ring. Optical Communication Modules will provide continuous on-line diagnostic monitoring of the optical signals of the primary and standby rings. If a fault is detected on the primary ring, the system will automatically switch to the standby ring. Therefore, self-healing recovery is provided for a failure within any segment of the ring.

The optical communication devices will also provide media conversion between the optical fibre and the copper 10BaseT RJ45 port on the Ethernet switch at each PLC control panel.

At control panels at which more than one PLC is housed, PLCs will be connected to the Ethernet switch. This option may also be exercised at locations where PLCs are installed in separate cabinets that are in very close proximity.

11.2 Network Performance and Protocol

All networks shall use standard Ethernet TCP/IP network protocol. Every network switch and router must at a minimum be capable of providing 10/100 Mbps auto-switching communications rates. Where multiple paths exist, the network devices shall be attached to at least two paths to provide redundancy. At locations where multiple LAN connections are there involving direct connectivity to the SCADA Network, a router shall be installed with the capability to support virtual local area networks (VLANs) to segregate traffic and not impede the control system network performance.

11.3 Network Hardware

SCADA Network Ethernet Switches connected to the SCADA network shall be rack mounted and powered from SCADA UPS.

Ethernet switches in the PLC control panels shall support connections to the PLCs and shall contain a minimum of 3 ports. One port shall be assigned to a portable programming terminal.

The SCADA Nodes, Servers, will be equipped with two Ethernet ports. One port will be connected to the SCADA Network and the other Ethernet port will be required for connection to the PLC Network.

PLC optical network interface devices shall be designed for use in a dual media ring configuration carrying Ethernet traffic. The optical network interface devices shall automatically switch to the standby fibre ring if the primary ring fails.

Optical Communication Modules shall be designed for standalone operation and shall provide media conversion between copper and fibre optic cable, and support Ethernet communication between PLCs and SCADA nodes. Optical Communication Modules shall provide on-line continuous diagnostics of the optical signals, detecting weak signals and channel faults.

11.4 PLC Communications

11.4.1 PLC-to-PLC Communication

PLCs shall communicate with each other via 10 Mbps Ethernet. Each PLC shall be assigned a unique TCP/IP address. PLC-to-PLC communication shall be via Message instructions

incorporated into ladder logic programs. Ladder logic programs shall be designed to optimize communication between PLCs by minimizing the number of messages and by arranging data tables within the PLC memory map to facilitate messaging.

The requirements for data transfer between PLCs shall be analyzed with respect to the need to initiate messages based on events (such as activation of an alarm condition) or on a regular timed interval. The 10 Mbps Ethernet speed will enable individual message transactions to be completed in sub-second durations. The ladder logic shall be designed to not exceed the response time of the process requirements.

11.4.2 SCADA Node Communication to PLCs

SCADA nodes will communicate with PLCs via the PLC Ethernet Network. Communications software will be installed and configured on each SCADA and programming computer. Poll records will be configured on SCADA nodes to meet SCADA requirements.

C. SCADA for Sewerage works

1.0 GENERAL DESCRIPTION AND SCOPE OF WORK

1.1 GENERAL

The proposed sewerage system of the Area Based Development project include the following components:

1. Automation & Control system for 8 Nos. of existing Sewerage Pump Stations for rehabilitation and up-gradation of the system.
2. Monitoring of manholes with level and flow sensors from a centralized location.

The principal items of work include:

a) Complete Instrumentation, Automation and SCADA Control facilities for the sewerage works.

b) All software, including SCADA Software, Application Software, PLC Software and Programming Tools, etc.

c) All associated cable data highway.

d) Interface Communication network.

e) Integration, Testing and Commissioning of the complete system.

The integrated Instrumentation and Control System shall ensure the supervision and coordination of all controls and monitoring functions of the facilities of the project and allow their coordinated operation controlled from the centralized location.

The requirement of Instrumentation facilities for the project have been covered under **"SCADA for: ELECTRICAL EQUIPMENT"** This section describes requirement of Automation and Control system required for the 8 Nos. Sewerage Pumping Stations. The mains functions, features, general and particular technical requirements of the Automation & Control System have been described. The Contractor shall implement these functions and features, both tailored to the process and equipment to be controlled and monitored.

1.2 SCOPE

a) The scope of supply includes all hardware and software required to ensure satisfactory operation of the SCADA system and facilities. The scope of work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's factories before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and erection and commissioning at site of various equipment and materials including associated hardware and software as specified in this document.

b) It is not the intent to specify completely herein, all details of design, construction and installation of the equipment and accessories. This implies that the Contractor shall supply all equipment, devices, apparatus, appliances, material and labor not herein specifically mentioned or included, but which may be found necessary to comply with the requirements implied in this specification. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be performed by the Contractor.

c) The Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in

accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability.

d) The system shall be consistent with modern practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

e) The equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the Employer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance therewith.

f) Whether specifically called for or not, all accessories and work required for the completion of the work are deemed to be as a part of the bidder's scope, unless and until mentioned very clearly in exclusions.

1.3 SCOPE OF WORK

The scope of work shall be a comprehensive functional system complete in all respects, including but not necessarily limited to the following:

f) Redundant Programmable Logic Controllers at each Pumping Station with control panels, software and programming tools, Input/Output modules, Interface cabinets, power supply units, communication interfaces, cables, etc. Each station shall also be provided two (2) Nos latest version of PC based Operator Work Stations each with 20" color TFT's, key boards, mouse for control, monitoring and programming function, one no. number heavy duty A3 size color inkjet printer, etc. These work stations shall perform control, monitoring and operation of all auxiliaries/drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC.

g) All instrumentation complete with instrumentation panels, all instruments comprising flow meters, level sensors, transmitters, pressure sensors, transducers, transmitters, float level switches, instrumentation control cables, etc. for meeting the functional requirements of the instrumentation system for the sewerage system facilities. The scope also includes :

- Connection of all instruments and equipment monitoring and control signals at all project sites to the PLC, as required.
- All instruments and associated power, control and signal cabling and wiring, as required.
- Calibration of all instruments at each plant site and provide calibration forms as required by this tender document.
- Establish and configure communications amongst field stations and SCADA Control Centre as per the requirement of this document.

h) Software - Supply of all necessary software, their license for use, and source codes for the process software that are specific for this project.

i) Interface Cabling - All interface cabling between Contractor-supplied equipment & Employer's panels within control room are included in the scope of the Contractor. The Contractor shall also install power cables from AC and DC Distribution Boards to the PLC's at sites, as required.

j) Underground drainage and manhole monitoring system for Eight (8) manholes.

Any other items not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

1.4 INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted that the dedicated communication links between SCADA Master Control Station at the Command & Control Centre and Sewerage Pumping Stations' Programmable Logic Controllers (PLCs)/ field devices shall be Fibre Optics Cables/ GSM Communication Network/ Radio Communication. These Communication links is the responsibility of the Employer and is therefore excluded from the scope of work of the Contractor. However, the scope of work of the contractor under this contract covers integration of the complete Sewerage system Instrumentation, Automation and SCADA system with the SCADA Master Control Station (s). The contractor shall have to co-ordinate with the other contractors in order to provide a fully functional SCADA system.

2.0 GENERAL TECHNICAL SPECIFICATION – AUTOMATION & CONTROL SYSTEM

The bidder may refer to the General Technical Specifications as given in the package 6A for Water Supply facilities, above.

3.0 TECHNICAL SPECIFICATIONS – AUTOMATION & CONTROL SYSTEM

3.1 PROGRAMMABLE LOGIC CONTROLLERS

This Specification covers the scope and technical requirements of the Programmable Logic Controllers.

PLC shall acquire data from the field devices, communicate with the control centre, execute control commands and perform all control functions.

The controller shall be supplied with the CPU, input/output scanner, inputs, outputs, memory, power supply, and all power and interface cables necessary to function as a complete and operable PLC system. Complete integration of control and automation system with PLC's including integrated performance guarantee is under the scope of the successful contractor.

All PLC units used shall be of the same manufacturer and of the same model and shall consist of equipment models that are currently in production. Interchangeability and interoperability of PLCs used shall be established by the Contractor.

3.2 SCOPE OF SUPPLY

The supply for PLC shall include all equipment and services for operation and maintenance, such as manufacturer's standard firmware, licensed PLC programming and debugging tools, test equipment, all software with license for use and source codes for the application programs, spare parts and full documentation along with training.

The system shall be delivered completely programmed for the complete and reliable operation of the plant.

All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient

documentation and program listing so that it is possible for the Purchaser to carry out modification at a later date.

The PLC system shall be provided with necessary interface hardware and software for interfacing with Fibre Optics/Other communication network/ GSM/Radio Communication for two-way transfer of signals with the control centre. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering.

All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be supplied and installed per the manufacturer recommendations.

3.3 GENERAL DESIGN REQUIREMENTS

a) The PLC shall be of modular in architecture, microprocessor design with interchangeability provided for all similar I/O modules and has capability for future expansion by the addition of required hardware and revision of user software.

b) The PLC shall be designed for high reliability, ease of maintenance and designed for continuous service in the harsh industrial environments prevailing at site.

c) The PLC shall be configured such that interdependence of functions is minimised and failure of any part of a PLC subsystem shall not directly affect the integrity of the unit, as a whole.

d) The PLC shall be designed and tested to operate in a highly electrical noisy environment and comply with IEC 60801 for electromagnetic compatibility.

e) All equipment shall be designed and constructed so that in the event of power interruption there shall be no loss of memory, and the equipment shall resume normal operation without manually resetting when power is restored.

f) All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling without the use of an internal fan.

g) The PLC shall support data access by a third-party server using Modbus or OPC. **Communication with control system -** The PLC's shall report the status of its input/output points to and accept control from a third-party System using OPC, Modbus or any other protocol. Where supported by the protocol, the PLC shall use report by exception to reduce network traffic.

h) All power supply cards, I/O module connections and other external interfaces shall be provided with suitable surge protection devices to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard.

3.4 PLC FUNCTIONS/FEATURES

The PLC processor unit shall be capable of executing the following functions:-

a) Receiving binary and analog signals from the field and operator initiated commands from control centre.
b) Implementing all logic functions for control, protection and annunciation of the equipment and systems.
c) Implementing modulating control function for certain applications as specified in the specification.

d) Issuing control commands.
e) Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
f) Performing self-monitoring and diagnostic functions and reporting failures to the control centre. Each controller shall have built-in functions of on-line self-diagnostics / watch dog features etc and shall report failures to the operators of the control system.
g) Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI). The PLC shall be capable of stand-alone operation in the event of failure of the communication link with the HMI subsystem.
h) Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

3.5 EQUIPMENT AND COMPONENTS

The PLC shall comprise of a central processing unit, input and output modules (digital and analog), communication/networking modules, voltage surge protection units, signal converters, isolators, power supply units, programming tools and other equipment necessary to form a complete working system.

The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future.

3.5.1 Processor Unit

The unit PLC equipment shall have adequate memory for functional capacity to perform the specified sequence of operation with the scheduled input and output points. The processor shall be provided with maximum available memory for logic programming storage, including on-board CPU memory and provision of available separate memory card modules. The user program and data shall be contained in non-volatile battery backed memory.

The processor unit shall, in addition to performing normal control functions in accordance with the program, monitor the status of its own operation as self- diagnostic and initiate pre-set logic shutdown sequence in the event of system malfunction. Clear visual indication on the health status of the unit shall be provided.

3.5.2 PLC Processor Redundancy

A redundant processor unit complete with power supply shall be provided to form a hot standby system with bump-less transfer of control operation without causing any disturbance whatsoever. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. To facilitate maintenance, manual switch over to the standby processor unit shall be effected by a key switch or through the programming tools.

The processor unit shall be capable for future expansion of input/output modules up to 30% without major modification or upgrading work being required. The capability of upgrading to better performance processor with higher speed and enhanced functionality with no change of the control program is desirable.

The processing unit shall be chosen such that, with the complete application program running, the

response times shall be better than 0.5 second for digital I/O points and 1 second for analog I/O points

3.5.3 Programming Tools

A set of user-friendly PLC programming software shall be provided as programming tools. The software shall be installed on a conventional notebook computer and capable of programming all types of processor units installed with the full set of processor supported instructions. This programming software shall allow editing and testing of application programs in formats that comply with the general standard specification.

The minimum requirements of the PLC programming software shall include routines for entering and editing programs; monitoring the status of the control programs; storing, duplicating and printing programs; cross referencing the register and I/O addresses; and controlling the states of the processor including diagnostic functions. The PLC programming software shall be capable of downloading / uploading control logic programs to the processor unit and incorporate fault diagnostic and export function enabling data manipulation and printing of the processor control program, register contents and cross-referencing of address.

3.5.4 Power Supply System

The power supply system shall have its output isolated from the mains input and be floating with respect to the mains earth. The power supply shall be protected against short circuits and power surge, and the power supply module of PLC shall contain its own over current and overvoltage protection

The normal power supply to the system shall be 230V 50Hz or 24V DC. PLC systems operating on AC supply shall be powered from uninterruptible power supply (UPS) equipment. The Contractor shall provide detailed power consumption requirements to the Employer to determine the rating of the UPS equipment.

All power supply cards, I/O module connections and other external interfaces shall be provided with suitable surge protection devices to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard. Degree of protection shall be minimum NEMA 1 (IP20)

Each PLC shall have long-life internal battery backup/ non-volatile memory for storing running data and programs. All software and firmware supplied must be of latest release/ version.

3.6 COMMUNICATION WITH SCADA CONTROL CENTRE

Communications with other intelligent devices such as SCADA Control Systems shall be able to be carried over various media such as fibre optics, GSM, radio, microwave, leased or dial up telephone lines, mobile telephone and IP network

The PLC shall report the status of its input/output points to and accept control from a third-party SCADA or Distributed Control System using OPC, Modbus or any other protocol as specified. The PLC system shall be provided with necessary interface hardware and software for dual fibre optic connectivity & interconnection with station wide LAN for two-way transfer of signals for the purpose of information sharing. The plant information shall be made available through an OPC compliant Ethernet link following TCP/IP standard. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this

ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering.

Two (2) Nos latest version of PC based Operator Work Stations each with 20" colour TFT's and key boards shall be provided for control & monitoring and programming function. One no. number heavy duty A3 size colour inkjet printer shall be provided along with operator work station. These work stations shall perform control, monitoring and operation of all auxiliaries/drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC.

4.0 SYSTEM INPUT / OUTPUT MODULES

4.1 GENERAL

Each PLC shall be supplied with requisite number of I/O cards in standard rack mounted modules with plug-in boards.

All Input/Output modules shall meet the following general requirements :

a) Standard rack-mounted I/O modules with plug-in boards shall be provided.
b) All necessary input/output interfacing equipment required for signal processing shall be provided.
c) In order to provide flexibility of arrangement and to economize on hardware, all digital and analog I/O cards shall be physically interchangeable within the I/O card frame. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off power supply.
d) Cards shall be labeled with module description to identify specific types of input cards from output cards.
e) Upon final selection and arrangement of I/O cards, the option shall be available to 'key' the card receptacles in the I/O structure to prevent future incorrect placement of I/O cards. Where physical keying is not available, the PLC shall have logic to prohibit processor running and produce fault indication on the processor module on detection of incorrect I/O placement.
f) A fault occurring on an input/output point shall not affect the operation of any other circuits. Removal/insertion of an input/output card shall not cause damage to a running PLC, otherwise interlock mechanisms shall be provided to prevent inadvertent removal/insertion of an input/output card until power is switched off.
g) The input/output cards shall be so allocated as to ensure a minimum number of equipment to be affected when a card is removed.
h) The number of input/output signals handled by a card shall not exceed 16.
i) Wiring to I/O module terminals or harness shall be at least 0.5mm^2.
j) Illuminated push button panels integral with input/output modules shall not be used unless prior approval has been obtained
k) Each I/O point shall be furnished with

- Indication for On/Off state of the field device.
- Protective network, such as surge protections, optical coupling and/or other isolating barriers
- Filter for noise reduction,
- Indication for module’s communication status/ fault
- indication Test points and fault indication

- lamps Fuse protection and fuse failure detection

l) Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.

m) Modules shall have indicators to display the status of communication, module health and input / output devices.

n) The possibility of isolating faulty channels.

4.2 CONTACT MULTIPLIPLICATION

Only one changeover contact shall be provided in MCC for control and interlock requirement. Further multiplication, if required, shall be done by the contractor in PLC system.

4.3 DIGITAL INPUT MODULES

The digital input (DI) modules shall be provided for the periodic scanning of digital inputs.

a) All inputs shall be protected by optical isolators. Any changes of state in the digital inputs shall be reported to the main processing module for further processing.

b) Status changes shall be time tagged to tag the time of input event with one millisecond accuracy.

c) Filtering shall be provided to protect against contact bounce or electrical noise on input lines.

4.4 DIGITAL OUTPUT MODULES

a) Digital output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays, etc. without any extra hardware. In the case of driving an actuator an interposing relay with adequately rated contacts or contactor shall be used for the interface.
b) All outputs shall be protected.
c) Contact bounce protection shall be provided.

4.5 ANALOG INPUT MODULES

Analog input modules shall convert an analog signal that is connected to the module's terminals into a digital value. All inputs shall be protected by optical isolators

Analog input shall be 4-20mA d.c. The analog inputs shall be multiplexed into a floating differential input analog-to-digital converter with inputs buffered and filtered to reduce mains noise. The accuracy shall be better than 0.5% over the entire operating temperature range.

The A/D converter shall have the following characteristics:

- better than or equal to 12 bits resolution,
- full range accuracy better than ± 0.1 %, over the operating temperature range,
- common mode rejection ratio more than or equal to 100 dB/ 50 Hz,
- serial mode rejection ratio more than or equal to 60 dB/ 50 Hz,
- inputs scanned and updated more than or equal to 4 (four) times per second,

To eliminate problems caused by common earth, the inputs shall be isolated from chassis ground and internal electric ground. The isolation shall be able to protect against a minimum of 400V and a transient of 1500V. The inputs shall be protected against high induced or pick-up voltages.

4.6 ANALOG OUTPUT MODULES

Some of the common features of the I/O modules shall be as follows:

a) All inputs shall be terminated with input protective network and necessary isolating barriers.
b) Filters for noise rejection.
c) Provision for isolation of faulty channels.
d) Test points and fault indication LEDs shall be provided to carry out module testing.
e) Surge withstanding facility as per IEEE standards.
f) All the modules shall be of addressable type.
g) Protection for continuous overload up to 200% of all input ranges.
h) Fuse protection and fuse failure detection.
i) Internal battery backup.
j) Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals
k) The D/A-converter shall have the following characteristics:

- better than or equal to 12 bits resolution, full range,
- full range accuracy better than ± 0.5%, over the operating temperature range,
- characteristics ± 1/2 LSB (Least Significant Bit) repeatability,
- ± 1 LSB linearity,
- common mode rejection ratio more or equal to 100 dB/ 50 Hz,
- differential mode rejection ratio more or equal to 60 dB/ 50 Hz.

Technical Particulars

1	Service	As per process
2	Functions	As per the control logic and Input/ Output lists for PLC
3	Software	To perform all the functions mentioned in the control logic and write-up
4	Expandability	20% of installed capacity
5	Interposing relays	Shall be provided for all the digital outputs (DO) including spare DO and for digital inputs wherever required.
6	Optical isolation for all digital inputs and outputs and galvanic isolation for analog inputs	Required
7	Processor Diagnostic function performance Minimum 16 bit performance with floating point capability performance Minimum 16 bit performance with floating point capability Memory module	Required Required To store programs, standard software to perform logic functions and diagnostic functions
8	Mounting	Inside the instrument control panel (ICP)
9	Inputs and outputs	As per I/O list
10	System loading	Max. 60% under worst loading conditions.
11	Type of input	NO/NC – contacts field selectable
12	Output	Relay outputs for driving MCC starter coils, motorised

		valves etc.
13	Spare I/Os	20% of each type, wired to terminal block.
14	Accessories	Programming software to be loaded in Purchaser's PC along with communication cable.

The digital input & digital output modules shall not have more than 16 channels in each module. The analog input modules shall not have more than 8 channels in each module.

4.7 INPUT / OUTPUT LIST

a) The Input/ Output modules shall be equipped to handle the I/O point requirements for each field station. The contractor may refer to the requirements of monitoring and control of various parameters specified in other sections of this document and provide with the bid an indicative Input/ Output list, as required to meet the requirements of the project. The actual number of I/O's may vary at the detailed engineering stage. The contractor shall provide the I/O modules based on the final I/O list prepared in consultation with the Employer, keeping in view the system functional requirements.

b) All I/O channels provided (used as well as additional / spares) irrespective of immediate application shall be wired from I/O module along with all required accessories and cables to the associated panel/cabinet with proper segregation and identification of Digital inputs and Digital outputs.

c) The contractor shall also keep an allowance of approximately 20 % active spare I/O points over and above the calculated I/O's by providing space for adding cards and terminations in future.

5.0 HUMAN MACHINE INTERFACE (HMI)

5.1 FEATURES

Human Machine Interface shall facilitate dialogue between the operator and the system. It is critical to the operation of the SCADA system and the Contractor shall provide a secure, flexible and `User-Friendly' interface by which engineers, supervisors and the operators may interact with the system and pipeline network by way of the computing equipment, database and software.

The graphic displays shall be windowed, fully supported with appropriate graphics and symbolic diagrams. All procedures shall be selectable by menu and context sensitive help displays shall be available.

The HMI system shall be fully integrated with database system. The operating system shall have proven industrial standard for high performance Graphical User Interface (GUI) and Application Programming Interface (API).
The database with complete record of telemetry points with static, dynamic and configuration parameters shall be resident in all the computer workstation. The configuration changes made in the database files will be automatically updated on all the workstations.
Every display request and manual input shall be acknowledged by the system with a direct and positive response that indicates if the entry has been accepted or not, for each step of multi-step procedure messages on the monitor shall be used to prompt the operator for the next expected entry.

5.2 FUNCTIONS OF THE HUMAN-MACHINE-INTERFACE

The following list shall constitute the minimum set of operating functions and their corresponding operator dialogue functions:

- Supervision and control of the complete Water supply system.
- Supervision and control of the other distant sites equipment,
- Supervision of the SCADA system,
- Processing of alarms and (data) messages,
- Processing of remote data and parameters,
- Obtaining information on the status and changes in status of the operation and the system,

5.3 ORGANIZATION OF THE HUMAN-MACHINE-INTERFACE

The Contractor shall supply all the equipment needed to implement the dialogue functions described above, taking into account the need for visualization in normal operation. Where workstations are each supplied with multiple screens, the intervention of more than one operator shall be possible with no disturbance to normal operation. In such cases the associated pointing device (trackball or mouse) and keyboard shall be shared between the multiple screens. The screens shall be aligned on the same level and the cursor associated with the pointing device shall be capable of passing from one to the other without interruption. The cursor shall only be assigned to one screen at once (called active screen). An icon displayed on the active screen shall allow the operator to designate by clicking on it to order the active screen to be changed.

5.4 ALARMS

Alarms are conditions that require user notification when detected. All alarms shall be presented to the user in a consistent manner.

Alarm conditions shall include, but not limited to, the following :

f) Telemetered or calculated value

g) Values returning to normal from a limit violation state

h) Uncommanded changes of a device state

i) Certain application program results

j) Hardware and/ or software failure.

Each alarm shall be subjected to a series of alarm processing functions.

5.5 ALARM DETECTION

Alarm monitoring shall be done for process variables, equipment malfunctions and control deviations.

Operating limits, viz., high limit, low limit or both high and low limits shall be assigned to specify analog inputs and calculated variables. The system shall check for violation of these limits to detect alarm conditions. Provision shall be made for variable alarm limits also.

In addition to the above operating limits, specified variables shall be assigned for specification viz., high-high limit, low-low limit or both high-high and low-low limits.

One of the states (0 or 1) of all digital inputs shall be designated as the alarm state. Status change for digital inputs shall be checked at each scan.

Return to normal state from alarm condition shall also be detected. For analog variables dead-band feature shall be provided to avoid cyclic alarms. Points oscillating around threshold shall be automatically blocked from coming as alarms, more than a certain number of times.

Provision shall be made to clarify alarms into major and minor categories.

5.6 ALARM MONITORING GUIDELINES

The following are general guidelines for selection of alarms to be monitored by the control system :

- The PLCs will generate alarm signals for all equipment status changes, process parameter values crossing high/low threshold limits, excessive rates of change, controlled device failure to respond and system diagnostic signals.
- All emergency or alarm conditions shall be reported to PLC panel as well as transmitted to the control centre for operator acknowledgement and response as determined by the alarm priority.
- Each alarm will be assigned a priority reflecting its severity and importance. All critical alarms requiring immediate action will generate a specific alarm annunciation with an audible alarm at the control centre. Other alarms that are not critical shall also generate audible alarm that can be distinguishable from the critical alarms. The operator at the control centre shall be able to acknowledge these alarms.
- Alert signals not requiring immediate operator attention will not generate audible alarm.

5.7 ALARM ACKNOWLEDGEMENT

An alarm shall be acknowledged by selecting an alarm acknowledge command when the item in alarm is selected on:

a) Any display showing the item in alarm

b) Any display showing the alarm message.

It shall be possible to acknowledge alarms individually. When an alarm is acknowledged, blinking of the alarm condition on displays and console visual indicators shall stop and the audible alarm turned off. The console alarm lamps shall be turned off when all alarms in the categories assigned to that console have been acknowledged.

6.0 CONTROL NETWORK TOPOLOGY

SCADA systems transfer real-time critical data and require robust, reliable communications for PLC to PLC, server to PLC, and server to workstation data exchanges. Communications media to convey signals between network devices shall be fibre optic cables, radio communication and copper cables. Fibre-optic cabling shall be installed for all backbone network segments that run between various process areas of the projects and between buildings. Copper cabling may be used for network segments that are completely within a single room, such as a control room, and between Fibre optic network nodes and devices such as PLCs, subject to the maximum

allowed distance for such applications. In order to ensure performance of critical data communications between PLCs and other nodes, the SCADA System will be implemented with Ethernet networks. For each network installation the topology shall be evaluated as part of the design. The topology for the SCADA Network shall be a star configuration at 100Mbps. For the PLC Network, the preferred topology shall be a star configuration. However a ring configuration or hybrid star-ring configuration may be used if facility layout makes a star topology impractical or too expensive. The configurations shall need to be evaluated and the best design identified. It shall be ensured that in each case a level of redundancy that ensures system reliability is achieved.

6.1 PLC NETWORK TOPOLOGY

The PLC Network shall provide 10 Mbps Ethernet communications between PLCs, SCADA nodes and the programming terminal. The topology will be a star topology. Fibre optic cables will extend from the PLC Network Ethernet switch to selected locations within the facility.

For the PLCs, a dual channel Fibre optic ring will connect the PLCs. The two channels, operating over separate Fibre, will communicate in opposite directions around the ring. Optical Communication Modules will provide continuous on-line diagnostic monitoring of the optical signals of the primary and standby rings. If a fault is detected on the primary ring, the system will automatically switch to the standby ring. Therefore, self-healing recovery is provided for a failure within any segment of the ring.

The optical communication devices will also provide media conversion between the optical fibre and the copper 10BaseT RJ45 port on the Ethernet switch at each PLC control panel.

At control panels at which more than one PLC is housed, PLCs will be connected to the Ethernet switch. This option may also be exercised at locations where PLCs are installed in separate cabinets that are in very close proximity.

6.2 NETWORK PERFORMANCE AND PROTOCOL

All networks shall use standard Ethernet TCP/IP network protocol. Every network switch and router must at a minimum be capable of providing 10/100 Mbps auto-switching communications rates. Where multiple paths exist, the network devices shall be attached to at least two paths to provide redundancy. At locations where multiple LAN connections are there involving direct connectivity to the SCADA Network, a router shall be installed with the capability to support virtual local area networks (VLANs) to segregate traffic and not impede the control system network performance.

6.3 NETWORK HARDWARE

SCADA Network Ethernet Switches connected to the SCADA network shall be rack mounted and powered from SCADA UPS.

Ethernet switches in the PLC control panels shall support connections to the PLCs and shall contain a minimum of 3 ports. One port shall be assigned to a portable programming terminal.

The SCADA Nodes, Servers, will be equipped with two Ethernet ports. One port will be connected to the SCADA Network and the other Ethernet port will be required for connection to the PLC Network.

PLC optical network interface devices shall be designed for use in a dual media ring configuration carrying Ethernet traffic. The optical network interface devices shall automatically switch to the standby fibre ring if the primary ring fails.

Optical Communication Modules shall be designed for standalone operation and shall provide media conversion between copper and fibre optic cable, and support Ethernet communication between PLCs and SCADA nodes. Optical Communication Modules shall provide on-line continuous diagnostics of the optical signals, detecting weak signals and channel faults.

6.4 PLC COMMUNICATIONS

6.4.1 PLC-to-PLC Communication

PLCs shall communicate with each other via 10 Mbps Ethernet. Each PLC shall be assigned a unique TCP/IP address. PLC-to-PLC communication shall be via Message instructions incorporated into ladder logic programs. Ladder logic programs shall be designed to optimize communication between PLCs by minimizing the number of messages and by arranging data tables within the PLC memory map to facilitate messaging.

The requirements for data transfer between PLCs shall be analysed with respect to the need to initiate messages based on events (such as activation of an alarm condition) or on a regular timed interval. The 10 Mbps Ethernet speed will enable individual message transactions to be completed in sub-second durations. The ladder logic shall be designed to not exceed the response time of the process requirements.

6.4.2 SCADA Node Communication to PLCs

SCADA nodes will communicate with PLCs via the PLC Ethernet Network. Communications software will be installed and configured on each SCADA and programming computer. Poll records will be configured on SCADA nodes to meet SCADA requirements.

7.0 UNDERGROUND DRAINAGE AND MANHOLE MONITORING SYSTEM

The contractor shall supply and install a remote alarm system for monitoring water levels in sewerage system manholes and transmission of manhole information to a remote location through a suitable communication media. A total of eleven (11) manholes are to be monitored at different locations of the project.

The requirement is to provide a comprehensive system for monitoring water level in manholes in which manhole information is collected by water level sensors, received by a remoter terminal unit and transmitted to the control centre through a suitable communication media. The system shall provide a three way alert system which includes route map, LCD display and speakers. The system shall enable collection of manhole data, convert these inputs into electrical outputs. transmitting it to the control centre, programmed so as to display all the alert information into readable text messages and display at the monitor in the control centre. The message shall display the exact location of the manholes in route map of the city. The system shall also generate an alarm on the occurrence of any abnormal event.

The system shall broadly comprise of Ultrasonic Water Level Sensors for providing real time measurement of water level in the manhole, remote terminal units to transmit the status of sensors

from inside the manholes to external nodes/relays and suitable gateway to interface with external communication for monitoring and generation of alarm alert at the control centre.

The medium of communication with the control centre can be Fiber Optics/Radio/GSM. The system shall enable USCL personnel to get the information regarding blocking of drainage, the area location and the exact place where it is blocked.

It shall also be possible to automatically turn on external pump via an auxiliary external relay to pump the water out or turn open/close the gate valve.

The system shall have the following features:

a) Robust design, corrosion limiting features and suitability for harsh industrial environment.

b) Easy to install and easy to service.

c) Easy to integrate, data acquisition and status of alarms can be easily used by other systems.

d) Applies smart phones and PC to facilitate the work of maintenance personnel and planners

e) Provide full control of the manhole covers.

D. SCADA for Electrical works

1.0 SCOPE OF WORK

1.1 BRIEF DESCRIPTION OF WORKS

The Electrical works to be carried out under Smart City Mission comprise of conversion of existing overhead power distribution lines to underground cabling and providing Ring Main Units (RMU) for ring circuits. The existing Pole mounted distribution substations are to be replaced with Compact Packaged type substations. Providing SCADA facilities for the Smart Compact Substations shall enable remote monitoring and control of the substations and power distribution network from a control centre, thus resulting in a more efficient management of the power system.

The project also envisages implementation of SCADA system for the 33/11 KV substation at Bailghar and two nos. of Compact Substations at Dudh Talai Raw Water Pumping Station.

This document related to SCADA facilities covers the following:

1. Providing Feeder Remote Terminal Units (RTUs) for the entire underground power distribution network.
2. Providing SCADA & Automation facilities for the 33/11 KV substation at Bailghar and its distribution feeders.

3. Providing SCADA & Automation facilities for two Compact Substations at Dudh Talai RWPS, two 1000KVA, 11/0.433 KV transformers (1 working + 1 standby).

The Feeder Remote Terminal Units of the underground power distribution network and 33/11 KV substation at Bailghar shall be ultimately connected to the SCADA Master Control Station at the Command & Control Centre through dedicated Fiber Optics Network/ GSM/Radio Communication links. The SCADA Master Control Station and Communication facilities being the responsibilities of others are therefore excluded from this document.

The works under this document also cover integration of all RTUs with the SCADA Master Control Station at Command & Control Centre. The contractor shall provide all communication interfaces and the necessary hardware and software for this purpose and also co-ordinate with the other contractor(s) in order to provide a fully functional SCADA system.

1.2 SCOPE

a) The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's factories before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and erection and commissioning at site of various equipments and materials including associated hardware and software as specified in this document.
b) It is not the intent to specify completely herein, all details of design, construction and installation of the equipments and accessories. This implies that the Contractor shall supply all equipment, devices, apparatus, appliances, material and labor not herein specifically mentioned or included, but which may be found necessary to comply with the requirements implied in this specification. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be performed by the Contractor.
c) The Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability.
d) Whether specifically called for or not, all accessories and work required for the completion of the work are deemed to be as a part of the bidder's scope, unless and until mentioned very clearly in exclusions.
e) Bidder shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability*1.3SCOPE OF WORKS FOR SCADA*

The scope of work shall be a comprehensive functional system complete in all respects, including but not necessarily limited to the following:

a) The Contractor shall supply and install the Remote Terminal/Feeder Remote Terminal Units at the various locations to acquire and process data from field devices and transmit the same to the SCADA Master Station. The scope of work of the contractor covers interfacing of the RTUs with the respective sub stations and also with the SCADA Master Station. This includes all interfaces, cabinets, cables, IED interface, communication interfaces and associated support requirements defined in this Specification. The units shall be complete with all software, software tools, troubleshooting and repair.
b) The Employer may not initially procure all capabilities specified in this document. Regardless of the RTU configuration purchased, the RTUs shall be capable of performing all functions specified herein with the addition of the necessary hardware and software modules in the field when required by the Employer.
c) It is the Employer's intent that the Contractor use as much standard hardware and software as possible; however, all of the functional requirements of this Specification must be satisfied. If the use of the Contractor's standard hardware and software requires that there is a need for additional items not specifically mentioned in this Specification, the Contractor shall supply all such items and provide a complete design that meets all of the Employer's functional requirements defined in this Specification.
d) The Contractor shall provide complete documentation, training, and testing to fully support the hardware and software provided.
e) In event of the configuration of RTUs given in Specification undergo changes during detailed engineering, the prices of particular item shall also be adjusted based on the unit prices as indicated in the price schedules for spares.
f) RTU shall collect all required data information from sub-RTUs (if any) and IEDs over designated communication links and/or via hardwired points from substation Control and Protection panels and transducers. Operation of field devices might also be possible via IEDs. Since polling IEDs is much more efficient and economical, preferences will be given to RTUs that have IEDs polling capability.
g) The RTUs are used for real-time monitoring and control of the power distribution network and will be located at the respective Sub Stations on the power network. The control systems will include the capability for control of substation, as required.
h) All interface cabling between Contractor-supplied equipment & Employer's panels are included in the scope of Contractor. All the instruments connections for RTU's shall be terminated in the interface Cabinets. The contractor shall include in the offer all necessary cables, materials and services required to install the RTU's and interconnect the I/O's with Control Cabinet/ interface cabinets and RTU's along with interfacing with telecommunication system.
i) The same type of new RTUs shall be installed at all Employer locations
j) The Contractor shall provide complete documentation, training, and testing to fully support the hardware and software provided.

1.4 INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted that the dedicated communication links between SCADA Master Control Station at the Command & Control Centre and the Power Distribution Network Feeder Remote Terminal Units, other Sub Station's Remote Terminal Units/ devices covered in this document shall be Fiber Optics Cables/ GSM Communication Network/ Radio Communication. These Communication links is the responsibility of the Employer and is therefore excluded from the scope of work of the Contractor. However, the scope of work of the contractor under this contract covers integration of all FRTUs/RTUs/ field devices of the Power Supply distribution network with the SCADA Master Control Station (s). The contractor shall have to co-ordinate with the other contractors in order to provide a fully functional SCADA system.

2.0 GENERAL TECHNICAL SPECIFICATION

This Specification covers the general technical requirements for the equipment required for Supervisory Control & Data Acquisition System (SCADA) for Electrical Supply facilities. The overall goal of the system is to monitor and control the Power Distribution Network and associated sub stations from a centralized location. The system shall enable the Employer to monitor and control the above and all related services in an efficient and reliable manner. To achieve this, the SCADA system must support the Operator's ability at the Control Centre to perform all the related functions by providing complete and accurate information to the operator.

This document, in conjunction with the detailed technical specifications, describes the main functions and features of the SCADA system. The Contractor shall implement these functions and features tailored for monitoring and control of the substations and entire power distribution network.

2.1 STORAGE AND OPERATING CONDITIONS

The contractor shall refer to the environmental conditions as applicable to this project. All equipment supplied shall be capable of withstanding any combination of environmental conditions in which it can be stored or operated without mechanical or electrical damage or degradation of performance as specified therein.

2.2 DISTRIBUTED OPEN SYSTEM REQUIREMENTS

The configuration of the SCADA system shall comprise a distributed computing environment with open system architecture.

The system architecture shall be open to accommodate hardware or application software additions, whether they are supplied by the original supplier or obtained from third party Vendors.

The operating system, support software, and applications, as well as APIs that provide standardized interfacing between System software and application software, shall be completely documented.

The following distributed and open-system design concepts shall be used:

f) ***The system configuration shall be based on Open Systems Standards in which the software is totally transparent, and any hardware can be replaced/upgraded/ expended with a functionally similar device and not necessarily manufactured by the original Vendor.***

g) The system must be built as independently as possible from the operating systems and hardware in order to enable the later evolutions.

h) The system shall be designed to provide the highest possible level of hardware and software independence through the use of standard products, standard toolkits, and application modularity.

i) The Supplier shall prove that the critical functions can operate with different hardware platforms and operating systems. Supplier shall also prove that the software corresponding to the critical functions have been able to follow the past operating systems and hardware evolutions.

j) Where required, all processing units of the system shall be interconnected using industry standard Local Area Networks (LANs). The LANs shall support the exchange of data from various system components that include: servers, user consoles, communications processors, terminals, gateways, etc.

2.3 GENERAL REQUIREMENTS

n) The system shall be consistent with modern practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

o) All equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the Project Specifications, Drawings, Engineering data, instructions, and recommendations of the equipment manufacturer as approved by the Employer.

p) The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion

q) All equipment shall be of modern compact design incorporating the latest developments in proven technology.

r) All equipment, cabinets and devices shall be heavy-duty type, designed for continuous industrial service.

s) All equipment provided shall be of modular construction and shall be capable of field expansion.

t) The field mounted equipment and system components shall be designed for installation in dusty, humid conditions prevailing at sites. The contractor shall refer to the environmental conditions as applicable to this project.

u) The equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the Employer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance therewith.

2.4 SYSTEM REQUIREMENTS

The system shall be governed by the following design requirements:

h) The control and monitoring system and the components shall be selected taking the following requirements into consideration:
- Reliability of components and subsystems,
- Scalability of the system for future extensions,
- Backward compatibility and Interoperability with other subsystems,
- Availability of spares,
- Ease of maintenance,
- Service availability and adaptability for future technology developments.

i) All equipment shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory, and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.

j) The equipment shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability.

k) All Electronic/ Digital equipment shall have high electro-magnetic and radio frequency interference immunity and shall not be affected by portable radio transmitters operated in the vicinity of the equipment. Any limitations shall be stated by the Supplier.
l) All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect plant operation.
m) Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 of IS 13947 Part I. All instruments of submersible type shall be protected to IP-68 of IS-13947 Part I.
n) All electrical and electronic systems and all associated software systems supplied under this contract shall conform with Year 2000 conformity requirements.

2.5 BASIC FUNCTIONAL REQUIREMENTS OF SCADA SYSTEM

The overall goal of the system is to monitor and control the substations, power feeder and distribution network from SCADA Master Station. To achieve this, the control system must support the Operator's ability at the Control Centre to perform all the related functions by providing complete and accurate information to the operator. The system shall be capable of performing the following functions as a minimum:

i) Collect, store and accurately analyse, reliable operating information in respect of power supply system parameters like current and voltage, active and reactive power, energy (instantaneous and integral), frequency, power factor, power quality data (total harmonic distortion), etc. in respect of sub stations, power supply distribution network.

j) Perform real time control, timer initiated events, process initiated events, system and program initiated events, operator initiated events, concurrent tasking and time tagging of inputs.

k) Assist operating personnel by alarm from abnormal operating conditions and equipment failure.

l) Acquire all measurements and perform all necessary calculations based on automatic and manual operator data inputs.

m) Accumulate and store equipment running times, transactions and changes in process, store information for use in preventive maintenance, management and inventory control

n) Store and retrieve all O&M information, manuals (both data and graphics)

o) Compile and prepare daily, weekly, monthly reports.

p) Manage and schedule all O & M functions.

2.6 CONTRACTOR TO INFORM HIMSELF FULLY

The contractor should ensure that he has examined the General Conditions, Specifications and Schedules as brought out in other sections of the bid document and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied.

The Employer shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Employer.

Site Locations - The Contractor may undertake site visits and obtain all required information before submission of the bid.

2.7 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS

The contractor shall note that all substation works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, in regard to the rules and regulations that may be applicable.

2.8 STANDARDS

a) It shall be the responsibility of the Contractor to ensure that the quality and specification of the equipment, materials and works are as per the latest revisions of national and international standards like IEC, IEEE, NEMA, etc. In case the requirements specified in this document are less stringent than the national or international norms or standards. the equipment covered by this specification shall, unless otherwise stated, be designed, manufactured and tested in accordance with the latest revisions of relevant Standards and shall conform to the regulations of local statutory authorities.

b) The standards referred to in the Specification shall govern in all cases wherever such references are made. In case of any conflict between such standards and this specification, the Contractor shall immediately point out the same to the Employer and seek clarification on the same.

c) Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately.

2.9 CONTRACTOR'S Liability

a) The Contractor should be in possession of a valid License from the Chief Electrical Inspector, Govt. of Rajasthan before commencement of the Work, failing which the Work Site will not be handed over to the Contractor.

b) The Chief Electrical Inspector, Govt. of Rajasthan or his Authorized Representatives may inspect the sites during construction. It is the responsibility of the Contractor to obtain pre-requisite formal clearance/ approval from the said Inspectorate prior to commissioning of any equipment. The Employer may assist the Contractor in obtaining the aforementioned approvals

c) The furnishing of engineering data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

d) All engineering data submitted by the Contractor after review by the Employer shall be part of the contract document.

2.10 DRAWINGS AND DATA TO BE SUBMITTED WITH BID

The Contractor shall submit along with the bid all drawings and other data as stated in different

sections of this document. These drawings and documents shall include sufficient details to demonstrate fully that all supplies and works included in the Contractor's scope shall conform to the provision and intent of these specifications. These drawings and documents shall provide sufficient details of the equipment, its description, type, size, Bill of Quantities, etc. Information related to arrangement, overall dimensions clearance etc. required for assembling and dismantling and furnishing the space requirements of all apparatus shall also be included to enable the Employer to determine the design and layout of the installation and to decide the compatibility of the bid.

2.11 DRAWINGS AND DOCUMENTS FOR APPROVAL

In addition to those stipulated in clause regarding drawings in General Conditions of Contract (GCC)/ Special Conditions of Contract (SCC), the following also shall apply in respect of Contractor Drawings:

f) All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

g) Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

h) The drawings submitted by the Contractor shall be reviewed by the Employer as far as practicable and shall be modified by the Contractor if any modifications and / or corrections are required by the Employer. However, it shall be the responsibility of the Contractor to review the proposed changes and point out any possible problems such as conflict with existing standards, etc. before incorporating the changes so that no technical problems may arise. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good line shall not alter the contract completion date.

i) The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.

j) The drawings submitted for approval to the Employer shall be in requisite number of copies.

All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the drawings shall be at the Contractor's risk. In case the contractor finds the necessity of making any changes in the design, such changes will again be subject to approval by the Employer.

The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:

c) The Contractor has completed the part of the Works covered by the subject document.

d) The Works appear to comply with requirements of Specifications

In no case the approval by the Employer of any document does imply compliance with neither all technical requirements nor the absence of errors in such documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

The following is the broad list of the documents and drawings that are to be approved by the Employer:

a) Function design document of all equipment.
b) Hardware description document of all equipment.
c) Data Sheets of each equipment, cables & auxiliary equipment
d) Bill of Quantities
e) RTU I/O list
f) General arrangement drawing with full dimensions of panels
g) Software details
h) RTU Test procedures
i) Cable Layout and details.
j) Cable and wiring schedule, as applicable.
k) Wiring diagram, where applicable.
l) Communication cables details.
m) Training documentation
n) Any other drawing/ document that is considered necessary for Employer's information/ approval.

All Designs / Drawings / Calculations/ Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts / works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

The drawings submitted for approval to the Employer shall be in requisite number of quantities. One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections". The contractor shall there upon furnish the Employer additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.

2.12 FINAL DRAWINGS AND DOCUMENTS

The successful Contractor shall be required to provide following drawings and documents in requisite type and quantities as per the requirements of the project:

c) All approved drawings of equipment and works related to a particular RTU.
d) Instruction manuals of all equipment that shall generally consist of:
    - Operation Manuals,
    - Maintenance Manuals,
    - Spare Parts Bulletins.
    - Copies of routine test reports of relevant equipment
    - Final Guaranteed and Other technical particulars of relevant equipment.
    - Final list of software applications and configuration details of those applications as downloaded for each RTU.
c) Copies of type tests and routine test reports of relevant equipment.
d) Final Guaranteed and Other technical particulars of relevant equipment.

e) Final list of software applications and configuration details of those applications as downloaded into RTUs for each substation.

f) Backup copies of all system configurations (RTU)

2.13 AS- BUILT DRAWINGS

After the completion of the onsite erection work, the contractor shall furnish requisite copies of the 'As-Built' drawings showing changes, if made, during erection for reference and record of the Employer. These Drawings also shall be stored on CD and supplied to Employer.

2.14 DESIGN CO-ORDINATION

Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best co-ordinate performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance

2.15 DESIGN IMPROVEMENTS

The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

2.16 QUALITY ASSURANCE AND QUALITY CONTROL

c) The contractor shall maintain quality control over suppliers, manufacturers, products, equipment, software, services, site conditions, and workmanship, to produce work of specified quality. The system provider shall maintain adequate records to provide evidence of quality and accountability. These records shall include results of inspections, tests, certification of processes and personnel, discrepant material and other quality requirements. These records shall be maintained and made available to the Employer at all times during the performance of the project and for the retention period as specified in the project. Inspection and testing records shall, as a minimum, indicate the nature of the observations, the number of observations made, and the number and types of deficiencies found. Records for monitoring work performance, inspection, and testing shall indicate the acceptability of work or products and the action taken to correct deficiencies. The records shall be retrievable and traceable from a component failure to demonstrate its original acceptance by test, inspection, and the criteria used.

The Contractor shall get the quality plans finalised and approved after the award of the Contract. The approved quality plan shall form the basis for inspection and acceptance of the equipment. The Employer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval.

d) Quality Assurance Plan for Site Installation & Commissioning

The contractor shall submit with the bids Quality Assurance Plan giving details of stage inspection during installation, pre-commissioning and commissioning tests and customer witness / hold points. The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. Test Procedure shall be specified giving for each test item (kind of test) a description, test method / standards, used instruments, sample/routine test, etc. The tests will also include the applicable standards and acceptance

criteria.

e) Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employers inspection of equipment/material.

The Employer or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractors/his vendors Quality Management and Control Activities.

2.17 SPARE CAPACITY

The system shall have 20 % spare capacity for all types of input/output modules. Spare I/O channels of modules shall be wired upto terminal blocks as defined in this document.

2.18 SPARE PARTS

a) Recommended Spare Parts

The contractor shall furnish an item wise list of recommended spare parts and quantity for three years satisfactory operation of the equipment with unit price of each part in a separate Schedule. Prices of these spare parts shall not be taken in to account in comparing Price Bid. Also, they will submit an undertaking to supply all spare parts for a minimum period of 10 (ten) years as and when any request is made before them on a chargeable basis.

b) Mandatory Spare Parts

for the mandatory spares list. Prices of these spare parts shall be taken into account in comparing price Bid.

2.19 CONSTRUCTION TOOLS & TACKLES

Contractor shall provide all required tools for enabling connection with any other intelligent device of which protocol, message structure, message organisation are known so the field station can scan the device and transmit the data to the control centre when polled. The Contractor shall submit a list of all such materials to the Employer before commencement of work at site. These tools and tackles shall not be removed from the site without the written permission of the Employer.

2.20 VENDOR LIST

Reference shall be made to the **Preferred Vendors list**. Equipment to be supplied and not covered or which does not conform to this list due to the manufacturer's own standards shall be submitted for approval.

2.21 REFERENCE STANDARDS

The system and equipment shall be designed, built, tested and installed to the latest revisions of the applicable standards. The table below gives a non – exhaustive list of the reference standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

IEC 60051	Recommendations for indicating electrical measuring instruments and their accessories

IEC 60065	Safety rules for electrical devices connected to a network procedures
IEC 60255	Electrical relays
IEC 60326	Printed boards
IEC 60332	Flame retarding characteristics of electric cable
IEC 60337	Auxiliary devices for control
IEC 60478	Level of spurious signal emission Stabilized power supplies, DC output
IEC 60529	Degree of protection
IEC 60617	Symbols on Electrical drawings
IEC 60625	Interface system for programmable measuring instruments (byte serial, byte parallel)
IEC 60721	Conditions of environment
IEC 60793 Part 1	Optical Fiber- Measurement and test procedures
IEC 60793 Part 2	Product specifications
IEC 60847	Local area network characteristics
IEC 60870	Telecontrol equipment and systems
IEC 60950	Equipment safety
IEC 61000	Electromagnetic compatibility for industrial process - measurement and control equipment
IEC 61131	Programmable Controllers
IEC 61158	Digital data communications for measurement and control - Fieldbus for use in industrial control systems
ISA S5.1	Instrumentation Symbols and Identification
ISO 2110	25-point connector
ISO 8802	Information process systems
ISO 9000	Quality management and quality assurance standards
ISO 9001	Quality systems: Model for quality assurance in design / development, production, installation and services
ISO 9002	Quality systems: Model for quality assurance in production and installation
ISO 9003	Quality systems: Model for quality assurance in field inspection and tests
ISO 11064	Ergonomic Design of Control centres
IEEE 1046	Application guide for distributed digital control and monitoring for power stations
ANSI / IEEE C37.1.1987	Definition, specification and analysis of systems used for supervisory control, data acquisition and automatic control.

2.22 ENGINEERING DATA

The furnishing of engineering data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

All engineering data submitted by the Contractor after review by the Employer shall be part of the contract document.

2.23 GURANTEED TECHNICAL PARTICULARS

The contractor shall fill up the Questionnaire for Guaranteed Technical Particulars of each item of the equipment as given in Annexure contained in Section-F (SCADA Master Control Station) of this document. The Contractor shall fill up the required particulars in these Annexure and submit

the same with the technical bid. The Contractor shall also furnish with the bid all other details as specified in different sections of this document. Any other information which in the opinion of the Contractor is required by the Employer for better understanding of the equipment offered shall also be submitted with the bid.

2.24 COMMISSIONING SPARES

It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.

2.25 TRAINING

It is important that Employer's personnel be adequately trained in the installation, operation, maintenance and expansion procedures and techniques of the supplied system. The training program shall be comprehensive and provide for interdisciplinary training on hardware and software. The training program shall be conducted in English. RTU training course shall cover the following:

a) RTU operation including data flow.

b) Troubleshooting, identification and replacement of faulty Modules.

c) Preventive maintenance of the RTU

d) Use of RTU configuration and Maintenance tool

e) All functional and Diagnostic testing of RTU

f) Database modification and configuration of RTU

The details of the training, training duration and the number of personnel shall be mutually discussed with the successful contractor.

Training Material

Comprehensive training manuals shall be provided for all training courses and the course material presented in a format that is easy to comprehend. The manuals shall serve as teaching aids during presentation of the training classes and as reference material after the training has been completed. It is not recommended that the Contractor use system technical documentation solely as the training manuals since system documentation is generally not written in an instructional format. Portions of system documentation may be incorporated into training manuals provided that the overall manual achieves an instructional format.

2.26 TYPES OF TESTS

The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

e) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to Commencement of commercial production against the order. The contractor shall indicate his schedule for carrying out these tests.

f) Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

g) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.

h) Tests during Manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.

The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Employer

2.27 TYPE TEST REPORTS

All Bids must be accompanied by the Type Test Certificates of equipment offered. Such type test certificates shall be acceptable only if :

a) Tests are conducted in an independent and well known testing laboratory,
b) Tests are conducted in manufacturer's own laboratory. In this case the laboratory must have ISO 9000 (or its equivalent) series certification; tests have been witnessed by technically qualified representatives of earlier clients or purchaser.
c) Test reports to be acceptable must be related directly to the equipment offered. Test reports for higher class of equipment are acceptable with commitment to perform the type tests free of any charge on the particular equipment(s) after the award of contract.
d) Type tests certificates are required for following equipment:
    i) Main processor unit
    ii) I/O modules
    iii) Power supply modules and charges
    iv) Communication interface modules
    v) HMI (Human-Machine Interface) display unit
    vi) Modems
    vii) Converters
    viii) Any other equipment considered necessary by the employer

Type Test Reports older than five (5) years on the date of Technical bid opening shall not be accepted.

2.28 TESTING

As part of the requirement of this specification section, it is the responsibility of the contractor to provide a complete operational control system. It is required that:

a) The contractor demonstrate that the system was fully tested during development and installation and is a functioning, integrated, and reliable system. The testing requirements require a comprehensive and progressive series of contractor conducted tests, contractor certifications, and Employer's witnessed tests.
b) The basic testing requirements shall require the contractor to provide tests for all equipment and software. All software and all equipment including mechanical, electrical, and all other equipment shall be tested both individually and together as an integrated system.
c) All tests shall be conducted in accordance with the relevant standards / Employer approved test procedures, forms and check lists submitted by the contractor.
d) As a minimum, the testing shall include the following:
    a) Factory Acceptance Testing (FAT)
    b) Site Acceptance Testing (SAT)

2.28.01 FACTORY ACCEPTANCE TESTING (FAT)

A Factory Acceptance Test and verification for all deliverable equipment, software, and associated documentation shall be performed prior to shipment of subsystems or major components. The equipment factory tests shall be performed to verify that the equipment is manufactured and assembled correctly, is operating as designed, and is in compliance with the contractual requirements for the deliverables. The factory test shall be performed to verify that the software and hardware will meet the functional and performance requirements of the complete project. The system shall (as a minimum) be tested for the following:

f) Operation requirements

g) Operating characteristics

h) Response times

i) Software functions

j) Deficiencies - Various process signals shall be simulated for carrying out above system tests.

The contractor shall submit a FAT test procedure to the Employer for approval prior to start of the FAT.

2.28.02 SITE ACCEPTANCE TESTING (SAT)

a) A Site Acceptance Test of the functions, software, and performance shall be conducted individually at each site (or facility process) after all elements have been installed and the I/O Point Checkout has been completed at each site.
b) The system Site Acceptance Tests shall be performed to verify complete operation of the system, requiring a repeat of much of the factory acceptance tests but with the equipment installed at the permanent sites, and shall include additional tests required to verify field-installed equipment which was not available at the factory.

2.29 INSPECTION & INSPECTION CERTIFICATE

a) The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have, at all reasonable times, access to the premises and works of the Contractor and their sub-contractor(s)/sub-vendors and shall have the right, at the reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.

b) The inspection of all equipment/systems required to be supplied to complete the works shall be done as detailed in this Specification. Only defect free and sound material meeting the technical requirements of this Specification and in accordance with a high standard of engineering would be acceptable to the Engineer's Representative.
c) For meeting these requirements of inspection, testing shall be carried out by the Contractor and certificates submitted to the Engineer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Valid calibration certificates for test instruments shall be produced for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of equipment/ system not covered by standards shall be tested in accordance with the details and program agreed between the Engineer and Contractor.
d) If during or after testing any item of the equipment/ systems fails to achieve its intended duty of otherwise prove defective it shall be modified or altered as necessary, retested and re-inspected as required by the Engineer.
e) No equipment/system is to be delivered to Site without the above described inspection having

been carried out or officially waived in writing by the Engineer's Representative.

f) The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the Contract.

2.30 GUARANTEES

The contractor shall be responsible to replace, free of cost with no transportation and insurance expenses to the Employer up to the destination of materials specified in schedule of dispatch, the whole or any part of the material which under normal and proper use and maintenance proves defective in material or workmanship for a period of three years for all SCADA Hardware equipment/ devices and five years for all SCADA Software from the date of "Employer's Taking Over". This shall override the warranty periods as defined in the General Contract Conditions. Such replacement shall be effected by the Contractor within a reasonable time actually required to do so. Contractor's liability upon the expiration of the period mentioned above shall terminate.

3.0 TECHNICAL SPECIFICATIONS OF RTU

3.1 GENERAL REQUIREMENTS

a) This section describes the overall function to be performed by RTUs. Each function is presented in sufficient detail to provide the Contractor with as much in sight as possible into both the initial and future requirements of the RTUs. The Contractor shall be fully responsible for proper achievement of the functions described in this document and shall propose any modifications and additions that he feels are needed to do so. All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

b) The RTU shall be installed at the Substations, Ring Main Units (RMUs)/ Sectionalizer locations to acquire data from field devices, status input devices, etc and transfer the required information to the SCADA Master Station(s). These shall also act as telecontrol devices for control of substation devices from the SCADA Master Control Station(s).

c) Due to rapidly evolving technology of the equipment specified herein, the requirements specified are to establish a baseline for the type of equipment required. In any case, the configuration shall be submitted to the Employer. To this end, the Contractor shall provide a detailed description, including a description of the structure, redundancy, hardware used (CPU, memory, storage, communication ports), maintenance and other details, as required.

d) The contractor shall demonstrate that the proposed system has been designed, installed and commissioned in accordance with the relevant international standards and the specification, and shall provide evidence of satisfactory service experience during the past three years.

3.2 RTU FUNCTIONS

All functional capability described below shall be provided by the Contractor even if a function is not initially implemented. As a minimum, the RTUs shall be capable of performing the following functions:

a) Collect and process status changes, analogue values and accumulated values from slave IEDs such as energy meters, protection relays, etc.
b) Receive and process digital and analogue commands from the master station at SCADA Control Centre.

c) Accept and respond to messages received from the master station(s).

d) Collect and process status changes, analogue values and accumulated values from slave IEDs such as energy meters, protection relays, reclosers

e) Support communication with SCADA Master Control centre over redundant communication links using standard protocol.

f) Support communication with IEDs over serial non-redundant communication links using one or more of IEC60870-5-103, MODBUS, or DNP3 protocols.

g) Support communication with future SCADA Master Control Centres.

All serial communication ports shall use RS-232C or RS-485 signal specifications to interface to above listed equipment. All ports shall be accessible to the Employer to attach the interface equipment and to provide access for the maintenance, test, and monitoring equipment. If the RTU does not support RS485 standard required for IED interface, the Contractor shall supply two (2) stand-alone RS232/485 converters installed inside of the RTU cabinet as an integral part of the RTU.

RTU shall be intelligent in support of the following :

a) Scanning of process inputs and acquire data by driving its I/O system.
b) Checking whether the measured value is within predetermined high and low limits and communicate the same to SCADA Control Centre along with time stamping.
c) Engineering unit conversion, i.e. relating the analog and digital input signals to the actual value and units.
d) Other processing like addition, subtraction, multiplication, division, etc. and other logic functions.
e) Storing the input data in the local memory.
f) Digital filtering of all input signals.
g) Support remote configuration like addition, deletion, modification and reassign different ranges to various parameters from the control centre.
h) Time stamping all exception reports.

3.3 HARDWARE REQUIREMENTS OF RTU

The configuration of each RTU shall include a Central Processing Unit (CPU) for processing the signals, a required number of Input/ Output modules, Communication modules for communication with the master station via modems and the power module for power supply requirement. The I/O modules shall include digital input, analog input, digital output, analog output and pulse input modules.

3.4 CENTRAL PROCESSING UNIT

The CPU shall be suitable to handle all types of communication protocols, perform data acquisition, perform address recognition, receive command messages, assemble response messages and execute control requests. The CPU shall also manage communications between all other functional modules of the RTU. The CPU shall effectively communicate with SCADA control centre as well as its peer RTUs for fault detection and control operations. It shall have an internal real time clock for data collection coordination and time tagging and provide synchronization by use of IEC protocols and have configurable capabilities to establish connections, link failures and reconnections.

Each Digital and Analogue I/O module shall be capable of interfacing with the respective inputs and outputs. These I/O modules shall be replaceable without reprogramming, reconfiguration and rewiring. A control disable switch shall be provided with each module with its status indication so that when the switch is put off the control outputs shall be disabled.

3.5 COMMUNICATION INTERFACES/ COMMUNICATION PORTS

a) RTUs shall support both internal and external communications functions.

b) RTUs shall have provision of communication with one or more slave IEDs using selection of protocols compatible to the one used by IEDs. The system shall be so designed that transmission of data and commands is not affected by the failure of any module not directly involved in the exchange of communication. Also, the internal network shall not be loaded even in the most heavy traffic in RTU's with ultimate capacity.

c) RTUs shall also be able to function as a sub-master within a SCADA system, which polls/controls multiple IEDs. The RTUs shall receive data from the IEDs by polling for data in a master-slave relationship.

d) RTU's shall provide redundant dual ports for direct communication to a dual redundant fiber optic data highway. RTU's shall be multi-dropped on a pair of communication channels for this purpose. Non availability of any one of the two communication channels shall not affect the functioning of the RTU multi-dropped on the pair. Upon failure of primary channel, RTU shall respond to CCU requests/interrogation on secondary channel automatically without loss of data and operation. System shall provide status on the availability of each of the channels. Other communication channels like Radio, GSM, cable links and dedicated or party-line communication channels shall also be supported. The data transfer rate for each shall be configurable in the software.

e) RTUs shall have following communication ports to communicate with master station(s), MFTs and configuration & maintenance terminal:
    i) Two TCP/IP Ethernet ports for communication with Master station(s) using IEC 60870-5-104.
    ii) Minimum two RS 485 interface ports located on the front of the RTU for communication with power meters over MODBUS protocol.
    iii) One port for connecting the portable configuration and maintenance tool for RTU.
    iv) In case RTU is used as a data concentrator, it shall have additional communication ports, Ethernet or Serial for IEC60870-5-104/101.

f) All ports shall be accessible to the Employer to attach the interface equipment and to provide access for the maintenance, test, and monitoring equipment.

g) RTU's shall also have capability to support simultaneous communications with multiple Control stations

h) The system shall also have provision for suitable number of spare ports.

i) Installation of communication links between the RTU and IEDs (including all interface modules as required), testing and commissioning shall be Contractor's scope of work. The Contractor shall investigate and examine in details compatibility of protocols used and all communication interface modules required at both ends of these links.

j) Complete details of the communication ports proposed to be provided shall be furnished by the contractor.

k) The Contractor shall demonstrate during testing that all analog values are updated within 2 sec. The updation time shall be demonstrated during FAT (routine) & SAT testing. The contractor to ensure that MFT's can communicate with RTU on IEC 60870-101/104 protocols.

l) **I**T SHALL BE POSSIBLE TO INCREASE THE NUMBER OF COMMUNICATION PORTS IN THE RTU BY ADDITION OF CARDS, IF REQUIRED IN FUTURE. THE RTU SHALL SUPPORT THE USE OF A DIFFERENT COMMUNICATION DATA EXCHANGE RATE (BITS PER SECOND) AND SCANNING CYCLE ON EACH PORT & DIFFERENT DATABASE FOR EACH MASTER STATION

3.6 MASTER STATIONS COMMUNICATION INTERFACE

The RTU shall provide redundant communication ports for communication with SCADA Master Station and, in the future, to Regional SCADA masters. Only one of the ports to each of the masters shall be used at a time. One of the ports shall be active and the other in standby mode. Switchover and failover of the communication links shall be controlled by the master stations and RTU shall respond on the communication channel it last received a message on.

For external communication each RTU shall have its own address. The communication from SCADA Control Centre and selected RTU shall be initiated by the addressing function. It shall also be possible to address all or a selected number of RTU's from the SCADA Control Centre.

The Employer will supply communication channels between the RTUs and the SCADA system master stations. The communication channels will consists of mainly optical fiber/ Radio/GSM. Use of dedicated or party-line communication channels shall be supported. The RTU data transfer rate for each RTU shall be configurable in the RTU software.

3.7 INTELLIGENT ELECTRONIC DEVICES COMMUNICATION INTERFACE

The RTU shall have provision for communication ports for communication with one or more slave IEDs using selection of protocols compatible to the one used by IEDs. RTU shall be able to function as a sub-master within a SCADA system, which polls/controls multiple IEDs. The RTU shall receive data from the IEDs by polling for data in a master-slave relationship.

Installation of serial communication links between the RTU and IEDs (including all interface modules as required), testing and commissioning shall be Contractor's scope of work. The Contractor shall investigate and examine in details compatibility of protocols used and all communication interface modules required at both ends of these links.

Based on current and voltage readings, the RTU shall integrate key substation functions such as metering, analog processing, and power quality measurement. Calculations shall provide the following readings:

Current and voltage for all phases of circuit configuration,

Power – kW, kVR, kVA,

Power factor,

Frequency,

Energy – kWh, kVRh, kVAh,

Power quality data - %THD (total harmonic distortion)

3.8 MASTER STATIONS COMMUNICATION CHANNEL CONTROL

All communication shall be initiated by the SCADA master stations.

The RTU shall perform as a slave on the communication channel to the Employer's SCADA system. Whenever the RTU must notify the master stations of an unusual condition at the RTU (such as a power fail/restoration, RTU internal hardware and software failure alarms, peripheral units and IEDs communication failure) or must transfer of changed data, the notification shall be accomplished within the frame-work of the periodic data acquisition exchange as defined in IEC60870-5-101 protocol

3.9 TIME SYNCHRONIZATION

All the archived data shall be retrieved locally and remotely by means of the configuration and operating software supplied with the control unit. RTU shall have the capability to time tag events and alarms to a resolution of 10 m or better. To complement this feature, the RTU clocks shall be synchronized to enable system wide comparisons to be made on the alarms and events recorded by different RTU's. The synchronisation shall be achieved by providing periodic time signals from the Master Control Station to all RTU's. The signals shall be used to update RTU clocks. If the data link from the Master Control Station to the RTU fails, the RTU shall continue to perform time tagging from its internal clock until the data link is restored and the clock is corrected to compensate for any time drift.
It shall also be possible to download data locally or remotely to a PC.

Time-stamped event archiving shall ensure that any change of information status shall generate a stored time-stamped event.

The storage capacity of the events to be transmitted to the remote control centre shall be specified by the contractor.

3.10 RTU TIME AND DATE FACILITY

The RTU shall have an internal Real Time clock for data collection coordination and time tagging. This shall include support for feeder fault detection.

3.11 SEQUENCE OF EVENT (SOE) COLLECTION FEATURE

a) The RTU shall collect digital status input data and time of operation from fast acting power system devices. To analyse the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of the RTU.

b) The RTU shall maintain a clock and shall time stamp events data with a time resolution of one millisecond (1.0 ms) or better. The time resolution will enable Employer's operating and engineering personnel to determine the sequential operation device state changes throughout the power system.

c) Any digital status input data point in the RTU shall be assignable as an SOE point. Each time a SOE status indication point changes the state, the RTU shall time tag the change and store in SOE buffer within the RTU.

d) SOE buffers shall be sized to store, as a minimum, a number of events equal to three times the number of Digital Points configured in the RTU. A minimum of 500 events can be stored

in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer shall be maintained by RTU on power supply interruption.

e) Separate and independent SOE data storage buffer shall be provided in the RTU for each master station.

3.12 DIGITAL CONTROL OUTPUT

On receiving commands from master station, the RTU shall operate field devices either by sending appropriate command to IED device or to field device control circuitry in control and protection panel hardwired via hardwired signals.

The RTU shall provide the capability for a master station to select and change the state of digital output points. Not more than one digital output shall be possible at a time. Selection of two or more contacts simultaneously or in quick succession without one having been completed, shall result in cancellation of both requests and shall return an alarm to the master station (this may not apply to set point outputs).

Device control will be used by the Employer to control power system devices including (in general):

- Two-state and four-state devices - circuit breakers, motor operated switches, auto/manual switches, relay disable/enable, and other two state devices.
- Variable Output Devices - raise/lower transformer load tap changers (LTC), and other variable output devices.

The RTUs shall have the capability for control outputs as described in the following schemes:

Double Point Momentary Control

A pair of outputs shall be supplied for each two state (open/close) control output point that drive control relays. One output shall be supplied for open, the other for close. Upon command from a master station using the select-before-operate sequence; the appropriate control output shall be operated for a preset (momentary) time period.

Raise / Lower Pulse Outputs

Raise/lower output controls will be used for transformer tap position settings. A pair of outputs shall be supplied for each (raise/lower) control output point that drives control relays. One output shall be supplied for raise, the other for lower. When commanded from the master station, the appropriate raise or lower output shall be operated for the selected time interval. The closure time interval for raise/lower output for each point shall operate over a range of 0.1 s to 4.0 s in a minimum of eight equal increments.

3.13 CONTROL SECURITY

All control operations shall use a true select/check/before execute command sequence between the RTU and Master Control Station. The sequence shall include the following functional capabilities:

a) The master station shall transmit a control selection message addressing the RTU and control point within the RTU, and indicate the control action desired.

b) The RTU shall initialize its control logic, reassemble the control selection message received and transmit the reassembled message to the master station. The information in the

message sent to the master station shall be generated by the RTU's point selection logic indicating the point and control function selected.

c) The master station will verify the returned message with the message sent, and if found valid, shall issue an execute control message to the RTU.

d) The RTU or IED shall only operate the control point selected after the check/before execute sequence above has been performed without error or interruption by any other message. The RTU or IED shall reset its control logic upon any error in the sequence or if the execute message is not received within a set time (user adjustable) after the command message is received at the RTU.

e) Every control associated with RTU shall report the status of the point after control execution. In case status has not changed within fixed specified time, it shall report the same to master station for not having executed the control.

3.14 CONTROL DISABLE/ LOCAL/REMOTE SELECTOR SWITCH

A manual Local/Remote switch shall be provided for each RTU to disable all control output interposing relays. When in the Local position, the Local/Remote switch shall allow testing of control outputs without activating the imposing control relays. In Local position, the switch shall physically disconnect both positive and negative power to interposing relay coils.

A status input indication shall be provided for the Local/Remote switch to allow the SCADA system to monitor the position of the switch.

No control interlocking logic shall be used.

3.15 CONTROL OUTPUT RELAYS

Control output interposing relays shall be supplied by the Contractor for each control output described above. Each control relay shall consist of two isolated single pole double throw contacts.

3.16 DUMMY RELAYS

The Contractor shall provide dummy relays to test readiness of the RTUs to operate control points. This relay shall be operated by Open/Close double command and configured as double point indication. At any time, the Control Centre operators shall be able to send switching commands to this relay and check for feedback status change confirming successful operation. These relays shall use the same coil power source as the other interposing relays installed in the RTU. Operation of the dummy relays shall be disabled whenever Local/Remote switch is in Local position.

3.17 ANALOGUE OUTPUT

The RTU shall be able to send set point commands to IED devices via communication link or analogue signal to appropriate field devices via hardwired link.

Hardwired analogue output shall be provided as set point control for AGC or other set point devices. The analogue output shall have an accuracy of ±0.2% of full scale at an ambient temperature of 25ºC. Mean accuracy shall drift no more than 0.01% per ºC over the temperature range of 5 ºC to +55 ºC. The Digital to Analogue converter shall have a minimum resolution of ± 2048 Counts (sign plus 11 data bits).

3.18 GENERAL INTERROGATION

SCADA system master station periodically and at initialization of the RTU, shall send general interrogation (GI) command to update status and values of all I/O points. At the time when the RTU receives GI command, it shall get a full update of all I/O points' status, values and flags and send this information to the master station as GI response. This response must not include events stored in the buffers but shall have an indication set if any events are available for reporting.

3.19 DATABASE MANAGEMENT

Each RTU shall be provided with a Data management system. The system shall provide a means of verifying the database in order to check consistency and completeness of the database. The contents of the database shall not be lost if there is a failure of the power supply. The RTU shall start and load its database after a power failure. The RTU shall allow the user to configure the database on site or from the Master Control Station.

3.20 DATA INTEGRITY

RTU shall provide error detection and control feature for data communication with the master station to ensure data integrity.

The RTU communication protocol shall report status changes by exception. The communication protocol shall also support an update demand scan of all status data by Master Control Stations regardless of the lack of any change data.

3.21 SCAN RATES

The overall RTU scan is defined as the time required to acquire complete data and update the RTU station data base and it shall be faster than RTU poll time by master station. Scan time includes the acquisition of data and processing and updating of RTU data base. The local scan rates for individual I/O modules shall be such that the time tagging resolution and system performance requirements are achieved.

3.22 SCAN GROUPS

Analog and digital output points shall be assignable to scan groups. A scan group shall be a specified set of data points within the RTU's central database which will be communicated to the master station when requested by a specific scan request.

3.23 INTERLOCKING LOGIC

The means to minimise the risk of incorrect sequence of operations or incorrect operation shall be included within the RTU as an interlocking function. If an I/O module is not operating and an input signal from it is required as an input to an interlocking expression, the control function shall be inhibited. The operator shall be able to override such inhibit signals only after taking action to specifically acknowledge alarms generated as a result of the incomplete input to the interlocking expression.

3.24 SCADA SECURITY

The main communication media for linking the RTUs with the SCADA Master Station shall be optical fiber cable network with back up communication link using GSM/ Radio Communication systems. It becomes mandatory to provide security to the SCADA system from intrusion/ damage,

any type of threats. The contractor shall ensure that adequate security features are provided in the system.

3.25 SYSTEM DIAGNOSTICS TEST FACILITIES

RTU's shall have a self-diagnostic feature and software watch dog timer devices to monitor and report the healthiness of CPU, memory, power supply, communication interfaces and input/output modules. RTU status shall be transmitted to the Master Control Station and displayed in the RTU status graphics. Comprehensive test facilities and self-diagnostic routines shall be provided to facilitate full functional testing of all subsystems, including the modules.

3.26 RTU DATA COMMUNICATIONS

a) The communication between RTUs and SCADA Master Station(s) shall be through Fiber Optics cable network. Alternatively RTUs shall also communicate with SCADA Master Station through Radio/ GSM cellular network using Wireless VPN. The contractor shall provide interoperability document specifying the functions and set of parameters.
b) The RTUs shall have the required serial ports for communication with SCADA Master Station (s), local devices and RS 485 port for MODBUS communication with IEDs. Each of the serial ports shall be individually selectable in RS 232 or RS 485 mode for operation from 9600 to 38400 bps. In addition to the serial ports, the RTU shall also have one Ethernet port for diagnostic functions.
c) The RTUs shall support IEC 60870-5-104 protocol for communication with SCADA Master Station (S) and IEC 608705-103/MODBUS set of protocols for communication with local devices. MODBUS over RS 485 interface protocol shall also be supported for communication with MFTs/ Energy Meters
d) RTUs shall support data transmission rates of 300 to 38400 Bps for RS 232, for MODBUS over RS 485 – 9600, 14400, 38400 Bps and 10/100 Bps for TCP/IP Ethernet ports.

3.27 EXCEPTION REPORTING

The RTU communication protocol shall report status changes by exception. The communication protocol shall also support an update demand scan of all status data by Master Control Stations regardless of the lack of any change data.

3.28 SUPPORT FEATURES

All support features as mentioned below will not be used now & may be required in future. However, the same shall be tested in Routine/ Factory Tests.

It should be possible to have following capabilities in the RTU by way of addition of required hardware limited to addition of I/O modules & communication card only & using the same firmware in future:

a) Support for Analog output in the form of 4 -20 mA standard current loops, etc.
b) Support for IEC 60870-5-103, IEC 61850 protocols & ability to act as a gateway for Numerical relays may have to be interfaced in future keeping Smart Grid vision in future.
c) RTUs to have required number of communication ports for simultaneous communication with Master station(s), /MFTs and RTU configuration & maintenance tool.
d) PLC support
e) Communication with at least two master stations simultaneously on IEC 60870-5-104 protocols.

f) Receiving and processing analog commands from master station(s) and Capability of driving analog output card.
g) RTU shall be capable of acquiring analog values through transducers having output as 4-20 mA, 0-10 mA, 0-+10 mA or +/- 5 volts etc using analog input modules.
h) Capability of time synchronisation with GPS receiver which may be required in future at the time of SMART GRID.

3.29 INPUT / OUTPUT MODULES

The RTU's shall include facilities for handling status input and control output points. The analog input/ output modules, digital input/output modules shall be interfaced to the data acquisition and control/processor through suitable I/O bus. The I/O modules shall be designed to reduce loading on RTU processor to the extent possible. Each I/O shall be protected against the reversal polarity of the power voltage to I/O.

All Input/ Output modules shall meet the following general requirements :

o) Standard rack-mounted I/O modules with plug-in boards shall be provided.
p) All necessary input/output interfacing equipment required for signal processing shall be provided.
q) In order to provide flexibility of arrangement and to economize on hardware, all digital and analog I/O cards shall be physically interchangeable within the I/O card frame.
r) All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off power supply. Interlock mechanisms shall be provided to prevent inadvertent removal/insertion of an input/output card until power is switched off.
s) Cards shall be labeled with module description to identify specific types of input cards from output cards.
t) Upon final selection and arrangement of I/O cards, the option shall be available to 'key' the card receptacles in the I/O structure to prevent future incorrect placement of I/O cards.
u) A fault occurring on an input/output point shall not affect the operation of any other circuits.
v) The input/ output cards shall be so allocated as to ensure a minimum number of equipment to be affected when a card is removed.
w) Wiring to I/O module terminals or harness shall be at least $0.5mm^2$.
x) Modules shall have indicators to display the status of communication, module health and input / output devices.

3.30 ANALOG INPUTS

a) The most preferable way for the RTU to collect analog data is by retrieving this data from substation IEDs. Points that are not available from IEDs (like substation batteries voltage, current and power readings, transformer temperatures or tap positions) should be hardwired to RTUs transducers for processing.

b) Next preferable way to collect analog data is by direct wiring of AC signals directly from CT and PT transformers to reduce wiring and eliminate number of transducers required. Other points shall be wired and processed through transducers the conventional way.

c) The least preferable way to collect analog data is through hardwiring field signals to RTU transducers and then to analog input modules.

3.31 INPUT / OUTPUT POINT TYPES

Requirements for each type of I/O point are described below :

AC Analog Inputs

The RTU shall have capability for direct AC analog inputs wired from current and voltage transformers for up to three 3-phase circuits eliminate need for transducers. RTU shall support AC signals with characteristics as listed below:

AC current inputs:

Nominal current: 1.0 A or 5.0 A @ 50 Hz for each phase, neutral and ground

Measurement range; 16 times of nominal

Accuracy ±0.2% of nominal

AC voltage inputs:

Nominal voltage: 110 VAC, 120 VAC, 63.5 VAC

Voltage measured between line-to-line, line-to-neutral

Measurement range 2.5 times of nominal

Accuracy ±0.2% of nominal

Based on current and voltage readings, the RTU shall integrate key substation functions such as metering, analog processing, and power quality measurement. Calculations shall provide the following readings:

Current and voltage for all phases of circuit configuration,

Power – kW, kVR, kVA,

Power factor,

Frequency,

Energy – kWh, kVRh, kVAh,

Power quality data - %THD (total harmonic distortion)

Digital Status Inputs

a) The RTU shall have capability to acquire status indications and events from substation IED slave devices through communication link using protocols compatible with these devices. Those points that are not available from IEDs (like station common alarms and indications, some switches statuses, internal RTU dummy breaker position) might be hardwired to the RTU digital input modules.

b) The digital status input interface shall be capable of accepting isolated wet or dry contact status inputs. The Contractor shall supply necessary sensing voltage, current limiting, optical isolation, and de-bounce filtering independently for each digital status input. The Contractor supplied sensing voltage shall not exceed 48 Volt D.C. The sensing voltage source shall be isolated from that of the RTUs logic power such that any noise or a short circuit across the sensing supply's output terminals would not disrupt the RTU operation other than the shorted digital status input.

c) The RTU shall have configurable feature to filter out generating of events for short duration changes of digital inputs. By default, changes of less than 20 ms duration shall be considered as no change.

d) The RTU shall store all status changes detected for retrieval by the Control Centres. For

communication delays or short-term failure of communication with a Control Centre, the RTU shall store a minimum of 300 status change events. The RTU shall report any overflow of this status change buffer to the master station.

Digital Input Module

Digital input (DI) modules shall be provided for periodic scanning of digital inputs. All inputs shall be protected by optical isolators. Any changes of state in the digital inputs shall be reported to the main processing module for further processing. Status changes shall be time tagged to tag the time of input event with one millisecond accuracy. Filtering shall be provided to protect against contact bounce or electrical noise on input lines.

The following types of status input points shall be included:

a) Single contact, two state status – a single contact shall represent both states of the monitored device. One position of the contact shall indicate an alarm or failure condition, while the other state of the contact shall depict the normal condition.
b) Double contact, two state status – The contacts shall be treated as a complimentary pair. Separate contacts shall be provided for representing each state of the monitoring device. One contact shall indicate an OPEN condition and the other contact shall indicate CLOSED condition of the monitored device.

DC Analog Inputs

a) If the RTU does not support software collection of analog data or the data is not available from IEDs or through direct AC analog inputs, it shall accept analog current inputs from transducers, which are isolated, unipolar or bipolar, 2 wire ungrounded differential signals with full resolution + 4 to +20 mA, 0 to +10 mA,10 to +10 mA.

b) The analogue input accuracy shall be 99.8% or better at 25ºC ambient temperature. Mean accuracy shall drift no more than 0.002% per 1ºC within the temperature ranges of 0ºC to +55ºC. Determination of accuracy shall be made while the analog multiplexer is operating at rated speed. The analogue to digital converter shall have a minimum resolution of ± 32767 counts (sign bit plus 15 data bits).

c) Each input shall have surge protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 mA (peak-to-peak). Overload up to 50% of the input shall not sustain any failure to the input.

d) The RTU shall make all appropriate signal level conversion and conditioning to allow full utilization of analogue input and meaningful reasonability checking. Including signal conditioning components, the input impendence shall not be greater than 5.0 kΩ. Input scaling shall allow for 20.0% over range.

Digital Output Modules

a) Digital output module shall be capable of switching ON/OFF inductive loads without any extra hardware. In the case of driving an actuator an interposing relay with adequately rated contacts or contactor shall be used for the interface.

b) On receiving commands from the master station, the RTU shall operate field devices either by sending appropriate command to IED device or to field device control circuitry in control and protection panel hardwired via hardwired signals.

c) The RTU shall provide the capability for the master station to select and change the state of digital output points. Not more than one digital output shall be possible at a time. Selection of two or more contacts simultaneously or in quick succession without one having been

completed, shall result in cancellation of both requests and shall return an alarm to the Command & Control Centre.

d) Device control will be used by the Employer to control power system devices including (in general):
    - Two-state and four-state devices - circuit breakers, motor operated switches, auto/manual switches, relay disable/enable, and other two state devices.
    - Variable Output Devices - raise/lower control of generators (AGC), transformer load tap changers (LTC), and other variable output devices.

e) The RTUs shall have the capability for control outputs as described in the following schemes.

Analog Output module

The analog output module shall provide DC voltage or current outputs. The module shall convert data from digital form to analog form using a digital-to-analog (DAC) converter.

The D/A-converter shall have the following characteristics:

a) Better than or equal to 12 bits resolution, full range,
b) Full range accuracy better than ± 0.5%, over the operating temperature range,
c) Common mode rejection ratio more or equal to 100 dB/ 50 Hz,
d) Differential mode rejection ratio more or equal to 60 dB/ 50 Hz.

3.32 PULSE ACCUMULATOR – ENERGY METERING VALUES

The RTU shall have capability to acquire accumulator values from substation IED slave devices through communication link using protocols compatible with these devices. If this information is not available from IEDs, pulse accumulator points shall be hardwired from field devices to the RTUs digital input modules.

The RTUs shall be capable of counting and storing the number of contact closures generated by a metering device external to the RTU. The device shall supply either an isolated Form A normally open or Form C contact. The accumulator shall be incremented one count for each cycle of the input (operation of the normally open and normally closed contact of form C contact). Accumulators' full scale shall be 32 bits. The accumulator shall be capable of accepting counts at a rate of ten counts per second. The count shall be frozen (present running value copied to a frozen counters buffer) and/or reset to 0 when commanded by the master station or when commanded by the locally generated contact inputs.

3.33 SOFTWARE

All software shall be implemented according to the Contractor's latest established design and coding standards. Complete and comprehensive documentation shall be provided for all software. Contractor may consider providing windows based software as it is preferred for its user friendliness. Contractor shall provide the RTU configuration software training to USCL Engineers for the purpose of maintenance and configuration modification

Operating System Software Features/ Requirements

a) A real-time non-proprietary operating system that is capable of managing the RTU applications shall be provided.

b) This software shall provide automatic restart of the RTU upon power restoration, memory parity errors, hardware failures, and manual request. The software shall initialize the RTU and begin execution of the RTU functions without intervention by the SCADA master station. All restarts shall be reported to the SCADA master station.
c) The software shall be prepared in a high level language and shall be documented in detail. No separate licensing charges or agreements shall attach to the RTU software or its underlying operating system.
d) In order to easily support the system under continuously changing site conditions all protocol, configuration, and application data must be contained in easily programmable non-volatile memory such as Flash EPROM. The RTU design shall be independent of any communication protocol that would impose restrictions on the flexibility or functionality of the RTU. Protocol changes shall be accomplished by software/firmware changes only.

Configuration Software

The configuration software shall be provided for configuration, maintenance and diagnostics functions. It shall offer configuration and parameterization of CPU and I/O Modules. The data acquisition includes channel reading, checking status of analog and digital inputs connected to different channels that are communicated to RTU. It shall be possible for the user to acquire data from power meters on MODBUS protocol connected to RS 485 port by proper configuration of the RTU.

Diagnostics functions shall provide continuous monitoring of the RTU and report RTU hardware errors to the SCADA master station. The software shall check for memory, processor and input/output errors and failures. It is desirable that internal diagnostics be sufficiently detailed to detect malfunctions to the level of the smallest replaceable component

The RTU shall facilitate isolation and correction of all failures and shall include features that promote rapid fault isolation and component replacement. All functional module nodes shall be designed with integrated on-line diagnostic functions. The results of these diagnostics shall be reported to the central processing module. The central module shall store this information and report it to the SCADA master station as permitted by the protocol.

The standard RTU software shall be capable of supporting, but not limited to, the following basic functions :

a) Data acquisition and processing, data preparation for transmission, data transmission and performing control functions commanded by the Master Control Station.
b) Alarm and event queue mechanism for Master Control Station integration of changes of status. Alarm queue reporting shall take high priority over the event queue reporting.
c) Secure telecommand using the select/check/actuate with open and close command outputs.

The alarms shall be assigned with priority levels at the RTU and transmitted according to priority. Alternatively, as soon as the alarms are received, these shall be transmitted. The method adopted shall be full described.

The occurrence of an alarm or an event shall be arranged for transmission to the SCADA master station at the earliest opportunity. Alarms or events occurring during a transmission of measurements shall be arranged for insertion at the next convenient point in the message cycle.

3.34 POWER SUPPLY MODULE

The power supply module shall be adequate enough to supply a fully equipped RTU rack. Each RTU shall be supplied with separate on/off power supply switch and fuse and also have the capability of automatic start up and initialization following restoration of power after an outage without need of intervention by the master station. All restarts shall be reported to the master station.

a) A manual reset push button shall be provided on the front of the power supply module for resetting all RTU modules by software. Power input fuses and LED's for monitoring shall be provided on the front of the module.
b) The modules shall incorporate surge suppression and isolation circuits to protect the RTU modules from external electrical disturbances.
c) Overvoltage and under voltage protection shall be provided within the power supply to prevent the RTU internal logic from being damaged as a result of a component failure in the power supply and to prevent the RTU internal logic from becoming unstable and causing misoperation as a result of voltage fluctuations.
d) The system shall have Power Supply module protection in reverse polarity, over current fuse, and under voltage.

RTU shall operate on 24 V DC power supply which shall either be wired from RMU switchgear Battery Charger System to RTU cabinet or a separate 24 V battery with battery charger shall be in-built in the RTU panel. The arrangement shall be complete with required accessories like MCB, TB, protection facilities. The DC circuits shall be protected by incoming circuit breakers, each circuit tapped through single MCB so as to provide an individual DC feeder to RTU, each of the I/O modules, modems and converters.

Each RTU shall have the capability of automatic start-up and initialization following restoration of power after an outage without need of the Control Centre intervention. Restart shall be reported to the Control Centre.

BATTERIES

Sealed, gel filled, maintenance free batteries shall be supplied.

The capacity of batteries shall be calculated in Amp/hrs and shall allow for 24 hours of operation with the absence of charging. After 24 hours RTU working on batteries without charging, the batteries capacity shall not fall below 50% of rated capacity to avoid damage to the batteries.

The batteries shall be integrated with battery charger and installed in substation battery room. As an alternative, charger and/or batteries could be mounted inside of the RTU cubicle, subject to approval of the Employer.

BATTERY CHARGER

Charger shall be Solid State with boost and float charging capability. Boost-charging the battery to full capacity shall be less than 8 hours. The output ripple shall not be more than 1% peak-to peak measured across the output of the charger when connected to the battery.

The battery charger shall be capable of sustaining without damage to itself, a continuous permanent short circuit across its output terminals.

The charge regulator shall incorporate a digital display of total charge and total discharge in Ampere-hours (AH). The charge controller shall also provide load-shedding facilities to prevent the discharge of the battery below 50% of its rated capacity.

POWER SUPPLY PROTECTION

Under and over voltage protection shall be provided within RTU power supply to prevent the RTU internal logic from being damaged as a result of a component failure in the power supply and to prevent the RTU internal logic from becoming unstable and causing mis-operation due to voltage fluctuation.

In case of power supply failure either at the RTU level or at any other component in the system, the RTU shall remain in a quiescent state.

Power interruptions in the 48VDC supply of less than 10 m shall not cause a break in normal operation of the RTU.

3.35 RTU Size and Expandability

RTU shall be equipped for the point counts defined in this document plus 20% spare. It shall be possible to expand the RTU capability for additional 100 % of the basic point counts by way of addition of hardware such as modules, racks, panels. However, RTU software and database shall be sized to accommodate such growth without requiring software or database regeneration.

List of required I/O points configured in RTUs database shall be provided by the Contractor. The Contractor shall be fully responsible for site survey, examining of latest approved versions of the Employer's substation documentation in order to determine exact number of I/O points.

The RTUs delivered shall have the capability to add additional point modules, but not installed, to expand the overall point count (total of physical required and 20% spare) of the RTU by a minimum of 20%. Expansion shall be accomplished in the field by the Employer by adding additional distribution of input/output modules within the main unit and RTU configuration software changes without need for adding new application software.

3.36 AVAILABILITY

The RTUs shall perform data acquisition and control of important equipment necessary for the operation of Employer's power system. Any failure of an RTU to perform its function shall adversely affect power system operation. **An availability of 99.9% is** required exclusive of communication channel availability. A RTU shall be considered unavailable when:

a) Any function is lost for all the points of a single type.
b) One entire data scan group failed.
c) More than one input card or output card of the same type fails.
d) One input card or output card of each type fails.
e) Failure of any modem.

3.37 COMPONENT IDENTIFICATION

Component reference numbers shall be marked adjacent to the components. Where this is not possible, components shall be identifiable from the layout drawings.

3.38 RTU AND INTERFACE PANELS

a) RTU and Interface equipment panels shall be free standing or wall mounting type and conform to NEMA-4 (IP55) requirement. The enclosure shall be fabricated using 2 mm thick CRC MS Steel and powder coated using seven tank process. The panels

shall have lockable front and rear doors and provided with gasket and fitting to keep out moisture, dust, gases and corrosives. The panel shall be naturally cooled.

b) The dimensions shall be suitable to accommodate RTU CPU and I/O modules, power supply accessories, Multifunction meter, Battery/Battery charger, terminal blocks, communication modem with power adaptor, Ethernet switch for FO connection and ease of intra-panel wiring/termination and maintenance thereafter. Suitably sized PVC perforated channels to be used for routing intra-panel wiring.

c) Removable type gland plates shall be provided at bottom of enclosure with 8-12 nos. knock out holes for single compression glands for control cable entry. Provision of entry shall be kept for extending CDMA and GSM modem antenna (if used) outside the enclosure. The panels shall also have an option to mount communication switch connecting to optical fiber network.

d) All doors, drawers, trays and other weight supporting parts shall be fabricated of metal and adequately reinforced to limit vibrations. All components and devices inside the panel shall be well highly and the panel shall have a tidy look.

e) Suitable ventilation, if necessary forced ventilation, and louver with dust filters shall be provided to maintain operating temperature under permissible limits of electronic components.

f) The Contractor shall furnish details of the shelf and inter-shelf wiring and the termination of the wiring harness between the RTU and the terminal block area. The connections from PCB's to back frame wiring shall preferably be with gold plated edge connectors which utilise a wiping action. Easy access to cabinet wiring for maintenance purpose is essential. The I/O point wires shall not be terminated directly on the I/O boards. Termination panel is to be provided for this.

g) The Contractor shall guarantee satisfactory functioning of the system hardware mounted in the panels even in the event of failure of air-conditioning unit.

h) Each panel shall have provision for mounting 20% extra function cards, power supplies, etc. and 20% spare terminals to take care of any additions in future.

i) Hardware mounted and wired panels of all systems included in the scope of the Contractor shall be subjected to burn-in operation for minimum 15 days before despatch to site.

3.39 MAINTENANCE SUPPORT HARDWARE

The Contractor shall provide two sets of maintenance support hardware to repair and maintain the RTUs. The minimum support hardware to be provided shall include minimum one of each of the following:

a) One maintenance RTU composed of one of each RTU units mounted on portable 19" frame including:

b) Processor unit,

c) Power supply unit,

d) One of each I/O peripheral boards,

e) Card extenders with test points for each connector pin (if applicable),

f) Test cable to connect any test equipment

3.40 COMMUNICATION TEST SET

The Contractor shall supply two sets of portable PC with software emulating protocols used by the RTU to monitor and test the RTUs operation and communication interfaces. The test set shall be capable of:

a) Master station simulation

b) RTU simulation

c) IED simulation

It shall have the capability of interfacing to either the analogue or digital side of the modem on communication line.

The test set shall be capable of receiving single and repeated messages using the supplied RTU Communication protocols (to master station and to IEDs). Each received message shall be checked for validity, including the check code. The test set shall maintain and display error counters so that the number of errors during a period of unattended testing can be accurately determined.

3.41 INPUT / OUTPUT LIST

d) The RTU's shall be equipped to handle the I/O point requirements described in Annexure - II as per each RTU types. The I/O list provided with this specification gives an indicative assessment of the total number of I/O's of each type required for the project. The actual number of I/O's may vary at the detailed engineering stage. The contractor shall provide the I/O modules based on the final I/O list prepared in consultation with the Employer, keeping in view the system functional requirements.

e) All I/O channels provided (used as well as additional / spares) irrespective of immediate application shall be wired from RTU I/O card along with interposing relays for DOs to the associated terminal strips in the cabinet with proper segregation and identification of Digital inputs and Digital outputs.

f) The contractor shall also keep an allowance of approximately 20 % active spare I/O points over and above the calculated I/O's by providing space for adding cards and terminations in future.

3.42 WIRING/CABLING REQUIREMENTS

The Contractor shall include in his scope the supply, laying, terminations of all cables and wires and all associated works, as required. This covers all signal, control, communication and all power supply cables, including auxiliary supply cable of RTU, battery charger, etc. The contractor's scope also covers supply and installation of all cable trays, cable glanding, cable supporting structures, all civil and mechanical works, as required for laying of cables.

All low voltage cables/ wires shall be adequately protected and separated as far as possible from power wiring. All wires shall be identified either by using ferrules or by colour coding. In addition, cables shall be provided with cable numbers at both ends, attached to the cable itself at the floor plate where it enters the cubicles.

Shielded cables shall be used for external Cabling from the RTU panels. The external cables (except communication cables) shall broadly have the following characteristics:

a) All cables shall have stranded copper conductor.

b) Minimum core cross-section of 2.5 mm2 for PT cables, 4 mm2 for CT cables, if applicable and 2.5 mm2 for Control outputs and 1.5mm2 for Status inputs
c) Shielding, longitudinally laid with overlap.
d) External marking with manufacture's name, type, core quantity, cross- section, and year of manufacture.

The Communication cable shall be of shielded twisted pairs and of minimum 0.22sq mm size.

3.43 CABLE TERMINATIONS AND WIRING

Terminal blocks shall be used for the connection of all external cables. Power supply terminals of all equipment and terminals of equipment contained within fabricated panels or cubicles shall comply with IEC 60947-7-1. It shall be single-level feed-through, screw or screw less type connection, DIN rail-mounted, vibration and corrosion resistant, and modular design suitable for harsh industrial environment.

Terminals shall be permanently identified by number or letter, and shall be so positioned as to permit convenient access for wiring. Adjacent rows of terminals shall not be closer than 150 mm. Power supply terminals shall be segregated form signal terminals and shall be shielded to prevent accidental contact.

Cable glands shall be provided to allow cable entry to the enclosures without degrading the required degree of protection.

At least 20% spare terminals shall be provided.

Terminal blocks shall have provision for disconnection (isolation), with full-depth insulating barriers made from moulded self-extinguishing material. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Required number of TBs shall be provided for common shield termination for each cable.

All terminal blocks shall be suitably arranged for easy identification of its usages such as CT circuits, PT circuits, analog inputs, status inputs, control outputs, auxiliary power supply circuits, communication signals etc. TBs for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, TBs for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

E. SCADA for Underground Ducting works

1.0 GENERAL DESCRIPTION AND SCOPE OF WORK

1.1 GENERAL

The proposed underground utility system of the Area Based Development project envisages Dewatering Submersible Pumps at nearly ten locations. In case flooding takes place in the underground duct, these pumps shall be used to lift water and discharge it into the road side drain. It is proposed to provide Ultrasonic Water Level Indicators for level measurement, generate alarm, control pump operation and transmit the information to the SCADA Master Station at Command and Control Centre.

1.2 SCOPE

a) The scope of supply includes all hardware and software required to ensure satisfactory operation of the Control system and facilities. The scope of work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's factories before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and erection and commissioning at site of various equipment and materials including associated hardware and software as specified in this document.

b) It is not the intent to specify completely herein, all details of design, construction and installation of the equipment and accessories. This implies that the Contractor shall supply all equipment, devices, apparatus, appliances, material and labour not herein specifically mentioned or included, but which may be found necessary to comply with the requirements implied in this specification. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be performed by the Contractor.

c) The Contractor shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the bidder has full responsibility for engineering and furnishing of a complete system. The bidder shall provide all material, equipment and services so as to make a totally integrated system together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability.

d) The system shall be consistent with modern practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

e) The equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the Employer, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance therewith.

f) Whether specifically called for or not, all accessories and work required for the completion of the work are deemed to be as a part of the bidder's scope, unless and until mentioned very clearly in exclusions.

1.3 SCOPE OF WORK

The scope of work shall be a comprehensive functional system complete in all respects, including but not necessarily limited to the following:

a) **Redundant Programmable Logic Controllers** at each Pumping Station with control panels, software and programming tools, Input/Output modules, Interface cabinets, power supply units, communication interfaces, cables, etc.

b) **All instrumentation** complete with Ultrasonic Water Level indicator, level sensors, transmitters, etc. The scope also includes :

- Connection of all instruments and equipment monitoring and control signals at all project sites to the PLC, as required.
- All instruments and associated power, control and signal cabling and wiring, as required.
- Calibration of all instruments at each plant site and provide calibration forms as required by this tender document.
- Establish and configure communications amongst PLC's and SCADA Control Centre as per the requirement of the project.

c) **Software -** Supply of all necessary software, their license for use, and source codes for the process software that are specific for this project.

d) **Interface Cabling** - All interface cabling between Contractor-supplied equipment & Employer's panels are included in the scope of the Contractor. The Contractor shall make all necessary power supply provisions.

Any other items not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

1.4 INTEGRATION WITH SCADA MASTER CONTROL STATION

It must be noted that the dedicated communication links between SCADA Master Control Station at the Command & Control Centre and Dewatering Pumping Stations' Programmable Logic Controllers (PLCs)/ field devices shall be Fibre Optics Cables/ GSM Communication Network/ Radio Communication. These Communication links is the responsibility of the Employer and is therefore excluded from the scope of work of the Contractor. However, the scope of work of the contractor under this contract covers integration of the complete Dewatering Pumping Stations' Instrumentation, Automation and Control system with the SCADA Master Control Station (s). The contractor shall have to co-ordinate with the other contractors in order to provide a fully functional SCADA system.

2.0 GENERAL TECHNICAL SPECIFICATION – AUTOMATION & CONTROL SYSTEM

The bidder may refer to the General Technical Specifications as given in the package 6 B for Water Supply facilities, above.

3.0 TECHNICAL SPECIFICATIONS – AUTOMATION & CONTROL SYSTEM

3.1 PROGRAMMABLE LOGIC CONTROLLERS

This Specification covers the scope and technical requirements of the Programmable Logic Controllers.

PLC shall acquire data from the field devices, communicate with the control centre, execute control commands and perform all control functions.

The controller shall be supplied with the CPU, input/output scanner, inputs, outputs, memory, power supply, and all power and interface cables necessary to function as a complete and operable PLC system. Complete integration of control and automation system with PLC's including integrated performance guarantee is under the scope of the successful contractor.

All PLC units used shall be of the same manufacturer and of the same model and shall consist of equipment models that are currently in production. Interchange ability and interoperability of PLCs used shall be established by the Contractor.

3.1.1 SCOPE OF SUPPLY

The supply for PLC shall include all equipment and services for operation and maintenance, such as manufacturer's standard firmware, licensed PLC programming and debugging tools, test equipment, all software with license for use and source codes for the application programs, spare parts and full documentation along with training.

The system shall be delivered completely programmed for the complete and reliable operation of the plant.

All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient documentation and program listing so that it is possible for the Purchaser to carry out modification at a later date.

The PLC system shall be provided with necessary interface hardware and software for interfacing with Fibre Optics/Other communication network/ GSM/Radio Communication for two-way transfer of signals with the SCADA Control centre. The exact data structure shall be as decided during detailed engineering. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering.

All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be supplied and installed per the manufacturer recommendations.

3.1.2 GENERAL DESIGN REQUIREMENTS

a) The PLC shall be of modular in architecture, microprocessor design with interchangeability provided for all similar I/O modules and has capability for future expansion by the addition of required hardware and revision of user software.

b) The PLC shall be designed for high reliability, ease of maintenance and designed for continuous service in the harsh industrial environments prevailing at site.

c) The PLC shall be configured such that interdependence of functions is minimised and failure of any part of a PLC subsystem shall not directly affect the integrity of the unit, as a whole.

d) The PLC shall be designed and tested to operate in a highly electrical noisy environment and comply with IEC 60801 for electromagnetic compatibility.

e) All equipment shall be designed and constructed so that in the event of power interruption there shall be no loss of memory, and the equipment shall resume normal operation without manually resetting when power is restored.

f) All system modules, main and expansion chassis shall be designed to provide for free air flow

convection cooling without the use of an internal fan.

g) The PLC shall support data access by a third-party server using Modbus or OPC. **Communication with control system -** The PLC's shall report the status of its input/output points to and accept control from a third-party System using OPC, Modbus or any other protocol. Where supported by the protocol, the PLC shall use report by exception to reduce network traffic.

h) All power supply cards, I/O module connections and other external interfaces shall be provided with suitable surge protection devices to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard.

3.1.3 PLC FUNCTIONS/FEATURES

The PLC processor unit shall be capable of executing the following functions:-

a) Receiving binary and analog signals from the field and operator initiated commands from control centre.
b) Implementing all logic functions for control, protection and annunciation of the equipment and systems.
c) Implementing modulating control function for certain applications as specified in the specification.
d) Issuing control commands.
e) Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
f) Performing self-monitoring and diagnostic functions and reporting failures to the control centre. Each controller shall have built-in functions of on-line self-diagnostics / watch dog features etc and shall report failures to the operators of the control system.
g) Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI). The PLC shall be capable of stand-alone operation in the event of failure of the communication link with the HMI subsystem.
h) Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

3.1.4 EQUIPMENT AND COMPONENTS

The PLC shall comprise of a central processing unit, input and output modules (digital and analogue), communication/networking modules, voltage surge protection units, signal converters, isolators, power supply units, programming tools and other equipment necessary to form a complete working system.

The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future.

Processor Unit

The unit PLC equipment shall have adequate memory for functional capacity to perform the specified sequence of operation with the scheduled input and output points. The processor shall be provided with maximum available memory for logic programming storage, including on-board CPU memory and provision of available separate memory card modules. The user program and data shall be contained in non-volatile battery backed memory.

The processor unit shall, in addition to performing normal control functions in accordance with the program, monitor the status of its own operation as self- diagnostic and initiate preset logic

shutdown sequence in the event of system malfunction. Clear visual indication on the health status of the unit shall be provided.

PLC Processor Redundancy

A redundant processor unit complete with power supply shall be provided to form a hot standby system with bump less transfer of control operation without causing any disturbance whatsoever. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. To facilitate maintenance, manual switch over to the standby processor unit shall be effected by a key switch or through the programming tools.

The processor unit shall be capable for future expansion of input/output modules up to 30% without major modification or upgrading work being required. The capability of upgrading to better performance processor with higher speed and enhanced functionality with no change of the control program is desirable.

The processing unit shall be chosen such that, with the complete application program running, the response times shall be better than 0.5 second for digital I/O points and 1 second for analog I/O points

Programming Tools

A set of user-friendly PLC programming software shall be provided as programming tools. The software shall be installed on a conventional notebook computer and capable of programming all types of processor units installed with the full set of processor supported instructions. This programming software shall allow editing and testing of application programs in formats that comply with the general standard specification.

The minimum requirements of the PLC programming software shall include routines for entering and editing programs; monitoring the status of the control programs; storing, duplicating and printing programs; cross referencing the register and I/O addresses; and controlling the states of the processor including diagnostic functions. The PLC programming software shall be capable of downloading / uploading control logic programs to the processor unit and incorporate fault diagnostic and export function enabling data manipulation and printing of the processor control program, register contents and cross-referencing of address.

Power Supply System

The power supply system shall have its output isolated from the mains input and be floating with respect to the mains earth. The power supply shall be protected against short circuits and power surge, and the power supply module of PLC shall contain its own over current and overvoltage protection

The normal power supply to the system shall be 230V 50Hz or 24V DC. PLC systems operating on AC supply shall be powered from uninterruptible power supply (UPS) equipment. The Contractor shall provide detailed power consumption requirements to the Employer to determine the rating of the UPS equipment.

All power supply cards, I/O module connections and other external interfaces shall be provided

with suitable surge protection devices to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard. Degree of protection shall be minimum NEMA 1 (IP20)

Each PLC shall have long-life internal battery backup/ non-volatile memory for storing running data and programs. All software and firmware supplied must be of latest release/ version.

3.2 COMMUNICATION WITH SCADA CONTROL CENTRE

Communications with other intelligent devices such as SCADA Control Systems shall be able to be carried over various media such as fibre optics, GSM, radio, microwave, leased or dial up telephone lines, mobile telephone and IP network

The PLC shall report the status of its input/output points to and accept control from a third-party SCADA or Distributed Control System using OPC, Modbus or any other protocol as specified. The PLC system shall be provided with necessary interface hardware and software for dual fibre optic connectivity & interconnection with station wide LAN for two-way transfer of signals for the purpose of information sharing. The information shall be made available through an OPC compliant Ethernet link following TCP/IP standard. The exact data structure shall be as decided during detailed engineering. All required data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering.

3.3 SYSTEM INPUT / OUTPUT MODULES

Each PLC shall be supplied with requisite number of I/O cards in standard rack mounted modules with plug-in boards.

All Input/Output modules shall meet the following general requirements :

a) Standard rack-mounted I/O modules with plug-in boards shall be provided.
b) All necessary input/output interfacing equipment required for signal processing shall be provided.
c) In order to provide flexibility of arrangement and to economize on hardware, all digital and analog I/O cards shall be physically interchangeable within the I/O card frame. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off power supply.
d) Cards shall be labelled with module description to identify specific types of input cards from output cards.
e) Upon final selection and arrangement of I/O cards, the option shall be available to 'key' the card receptacles in the I/O structure to prevent future incorrect placement of I/O cards. Where physical keying is not available, the PLC shall have logic to prohibit processor running and produce fault indication on the processor module on detection of incorrect I/O placement.
f) A fault occurring on an input/output point shall not affect the operation of any other circuits. Removal/insertion of an input/output card shall not cause damage to a running PLC, otherwise interlock mechanisms shall be provided to prevent inadvertent removal/insertion of an input/output card until power is switched off.
g) The input/output cards shall be so allocated as to ensure a minimum number of equipment to be affected when a card is removed.
h) The number of input/output signals handled by a card shall not exceed 16.
i) Wiring to I/O module terminals or harness shall be at least $0.5mm^2$.

j) Illuminated push button panels integral with input/output modules shall not be used unless prior approval has been obtained

k) Each I/O point shall be furnished with

- Indication for On/Off state of the field device.
- Protective network, such as surge protections, optical coupling and/or other isolating barriers
- Filter for noise reduction,
- Indication for module's communication status/ fault
- Indication Test points and fault indication
- lamps Fuse protection and fuse failure detection

l) Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.

m) Modules shall have indicators to display the status of communication, module health and input / output devices.

n) The possibility of isolating faulty channels.

3.3.1 CONTACT MULTIPLIPLICATION

Only one changeover contact shall be provided in MCC for control and interlock requirement. Further multiplication, if required, shall be done by the contractor in PLC system.

3.3.2 DIGITAL INPUT MODULES

The digital input (DI) modules shall be provided for the periodic scanning of digital inputs.

a) All inputs shall be protected by optical isolators. Any changes of state in the digital inputs shall be reported to the main processing module for further processing.

b) Status changes shall be time tagged to tag the time of input event with one millisecond accuracy.

c) Filtering shall be provided to protect against contact bounce or electrical noise on input lines.

3.3.3 DIGITAL OUTPUT MODULES

a) Digital output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays, etc. without any extra hardware. In the case of driving an actuator an interposing relay with adequately rated contacts or contactor shall be used for the interface.

b) All outputs shall be protected.

c) Contact bounce protection shall be provided.

3.3.4 ANALOG INPUT MODULES

Analog input modules shall convert an analog signal that is connected to the module's terminals into a digital value. All inputs shall be protected by optical isolators

Analog input shall be 4-20mA d.c. The analog inputs shall be multiplexed into a floating differential input analog-to-digital converter with inputs buffered and filtered to reduce mains noise. The accuracy shall be better than 0.5% over the entire operating temperature range.

The A/D converter shall have the following characteristics :

- better than or equal to 12 bits resolution,
- full range accuracy better than ± 0.1 %, over the operating temperature range,
- common mode rejection ratio more than or equal to 100 dB/ 50 Hz,
- serial mode rejection ratio more than or equal to 60 dB/ 50 Hz,
- inputs scanned and updated more than or equal to 4 (four) times per second,

To eliminate problems caused by common earth, the inputs shall be isolated from chassis ground and internal electric ground. The isolation shall be able to protect against a minimum of 400V and a transient of 1500V. The inputs shall be protected against high induced or pick-up voltages.

3.3.5 ANALOG OUTPUT MODULES

Some of the common features of the I/O modules shall be as follows:

a) All inputs shall be terminated with input protective network and necessary isolating barriers.
b) Filters for noise rejection.
c) Provision for isolation of faulty channels.
d) Test points and fault indication LEDs shall be provided to carry out module testing.
e) Surge withstanding facility as per IEEE standards.
f) All the modules shall be of addressable type.
g) Protection for continuous overload up to 200% of all input ranges.
h) Fuse protection and fuse failure detection.
i) Internal battery backup.
j) Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals
k) The D/A-converter shall have the following characteristics:

- better than or equal to 12 bits resolution, full range,
- full range accuracy better than ± 0.5%, over the operating temperature range,
- characteristics ± 1/2 LSB (Least Significant Bit) repeatability,
- ± 1 LSB linearity,
- common mode rejection ratio more or equal to 100 dB/ 50 Hz,
- differential mode rejection ratio more or equal to 60 dB/ 50 Hz.

Technical Particulars

1	Service	As per process
2	Functions	As per the control logic and Input/ Output lists for PLC
3	Software	To perform all the functions mentioned in the control logic and write-up
4	Expandability	20% of installed capacity
5	Interposing relays	Shall be provided for all the digital outputs (DO) including spare DO and for digital inputs wherever required.
6	Optical isolation for all digital inputs and outputs and galvanic isolation for analog inputs	Required
7	Processor Diagnostic function performance Minimum 16 bit performance with floating point capability performance Minimum 16 bit performance with floating point capability Memory module	Required Required To store programs, standard software to perform logic functions and diagnostic functions

8	Mounting	Inside the instrument control panel (ICP)
9	Inputs and outputs	As per I/O list
10	System loading	Max. 60% under worst loading conditions.
11	Type of input	NO/NC – contacts field selectable
12	Output	Relay outputs for driving MCC starter coils, motorised valves etc.
13	Spare I/Os	20% of each type, wired to terminal block.
14	Accessories	Programming software to be loaded in Purchaser's PC along with communication cable.

The digital input & digital output modules shall not have more than 16 channels in each module. The analog input modules shall not have more than 8 channels in each module.

3.4 INPUT / OUTPUT LIST

a) The Input/ Output modules shall be equipped to handle the I/O point requirements for each pump. The contractor may refer to the requirements of monitoring and control of various parameters specified in other sections of this document and provide with the bid an indicative Input/ Output list, as required to meet the requirements of the project. The actual number of I/O's may vary at the detailed engineering stage. The contractor shall provide the I/O modules based on the final I/O list prepared in consultation with the Employer, keeping in view the system functional requirements.

b) All I/O channels provided (used as well as additional / spares) irrespective of immediate application shall be wired from I/O module along with all required accessories and cables to the associated panel/cabinet with proper segregation and identification of Digital inputs and Digital outputs.

c) The contractor shall also keep an allowance of approximately 20 % active spare I/O points over and above the calculated I/O's by providing space for adding cards and terminations in future.

3.5 HUMAN MACHINE INTERFACE (HMI)

3.5.1 FEATURES

Human Machine Interface shall facilitate dialogue between the operator and the system. It is critical to the operation of the SCADA system and the Contractor shall provide a secure, flexible and `User-Friendly' interface by which engineers, supervisors and the operators may interact with the system and pipeline network by way of the computing equipment, database and software.

The graphic displays shall be windowed, fully supported with appropriate graphics and symbolic diagrams. All procedures shall be selectable by menu and context sensitive help displays shall be available.

The HMI system shall be fully integrated with database system
The operating system shall have proven industrial standard for high performance Graphical User Interface (GUI) and Application Programming Interface (API).
The database with complete record of telemetry points with static, dynamic and configuration parameters shall be resident in all the computer workstation.
The configuration changes made in the database files will be automatically updated on all the workstations.
Every display request and manual input shall be acknowledged by the system with a direct and positive response that indicates if the entry has been accepted or not, for each step of multi-step

procedure messages on the monitor shall be used to prompt the operator for the next expected entry.

3.5.2 FUNCTIONS OF THE HUMAN-MACHINE-INTERFACE

The following list shall constitute the minimum set of operating functions and their corresponding operator dialogue functions:

- Supervision and control of the complete Water supply system.
- Supervision and control of the other distant sites equipment,
- Supervision of the SCADA system,
- Processing of alarms and (data) messages,
- Processing of remote data and parameters,
- Obtaining information on the status and changes in status of the operation and the system,

3.5.3 ORGANIZATION OF THE HUMAN-MACHINE-INTERFACE

The Contractor shall supply all the equipment needed to implement the dialogue functions described above, taking into account the need for visualization in normal operation. Where workstations are each supplied with multiple screens, the intervention of more than one operator shall be possible with no disturbance to normal operation. In such cases the associated pointing device (trackball or mouse) and keyboard shall be shared between the multiple screens. The screens shall be aligned on the same level and the cursor associated with the pointing device shall be capable of passing from one to the other without interruption. The cursor shall only be assigned to one screen at once (called active screen). An icon displayed on the active screen shall allow the operator to designate by clicking on it to order the active screen to be changed.

3.5.4 ALARMS

Alarms are conditions that require user notification when detected. All alarms shall be presented to the user in a consistent manner.

Alarm conditions shall include, but not limited to, the following:

a) Telemetered or calculated value

b) Values returning to normal from a limit violation state

c) Un-commanded changes of a device state

d) Certain application program results

e) Hardware and/ or software failure.

Each alarm shall be subjected to a series of alarm processing functions.

3.5.5 ALARM DETECTION

Alarm monitoring shall be done for process variables, equipment malfunctions and control deviations.

Operating limits, viz., high limit, low limit or both high and low limits shall be assigned to specify analog inputs and calculated variables. The system shall check for violation of these limits to detect alarm conditions. Provision shall be made for variable alarm limits also.

In addition to the above operating limits, specified variables shall be assigned for specification viz., high-high limit, low-low limit or both high-high and low-low limits.

One of the states (0 or 1) of all digital inputs shall be designated as the alarm state. Status change for digital inputs shall be checked at each scan.

Return to normal state from alarm condition shall also be detected. For analog variables dead-band feature shall be provided to avoid cyclic alarms. Points oscillating around threshold shall be automatically blocked from coming as alarms, more than a certain number of times.

Provision shall be made to clarify alarms into major and minor categories.

3.5.6 ALARM MONITORING GUIDELINES

The following are general guidelines for selection of alarms to be monitored by the control system:

- The PLCs will generate alarm signals for all equipment status changes, process parameter values crossing high/low threshold limits, excessive rates of change, controlled device failure to respond and system diagnostic signals.
- All emergency or alarm conditions shall be reported to PLC panel as well as transmitted to the control centre for operator acknowledgement and response as determined by the alarm priority.
- Each alarm will be assigned a priority reflecting its severity and importance. All critical alarms requiring immediate action will generate a specific alarm annunciation with an audible alarm at the control centre. Other alarms that are not critical shall also generate audible alarm that can be distinguishable from the critical alarms. The operator at the control centre shall be able to acknowledge these alarms.
    - Alert signals not requiring immediate operator attention will not generate audible alarm.

3.5.7 ALARM ACKNOWLEDGEMENT

An alarm shall be acknowledged by selecting an alarm acknowledge command when the item in alarm is selected on:

a) Any display showing the item in alarm

b) Any display showing the alarm message.

It shall be possible to acknowledge alarms individually. When an alarm is acknowledged, blinking of the alarm condition on displays and console visual indicators shall stop and the audible alarm turned off. The console alarm lamps shall be turned off when all alarms in the categories assigned to that console have been acknowledged.

3.6 CONTROL NETWORK TOPOLOGY

SCADA systems transfer real-time critical data and require robust, reliable communications for PLC to PLC, server to PLC, and server to workstation data exchanges. Communications media

to convey signals between network devices shall be fiber optic cables, radio communication and copper cables. Fibre-optic cabling shall be installed for all backbone network segments that run between various process areas of the projects and between buildings. Copper cabling may be used for network segments that are completely within a single room, such as a control room, and between Fibre optic network nodes and devices such as PLCs, subject to the maximum allowed distance for such applications. In order to ensure performance of critical data communications between PLCs and other nodes, the SCADA System will be implemented with Ethernet networks. For each network installation the topology shall be evaluated as part of the design. The topology for the SCADA Network shall be a star configuration at 100Mbps. For the PLC Network, the preferred topology shall be a star configuration. However a ring configuration or hybrid star-ring configuration may be used if facility layout makes a star topology impractical or too expensive. The configurations shall need to be evaluated and the best design identified. It shall be ensured that in each case a level of redundancy that ensures system reliability is achieved.

3.7 PLC NETWORK TOPOLOGY

The PLC Network shall provide 10 Mbps Ethernet communications between PLCs, SCADA nodes and the programming terminal. The topology will be a star topology. Fibre optic cables will extend from the PLC Network Ethernet switch to selected locations within the facility.

For the PLCs, a dual channel Fibre optic ring will connect the PLCs. The two channels, operating over separate Fibre, will communicate in opposite directions around the ring. Optical Communication Modules will provide continuous on-line diagnostic monitoring of the optical signals of the primary and standby rings. If a fault is detected on the primary ring, the system will automatically switch to the standby ring. Therefore, self-healing recovery is provided for a failure within any segment of the ring.

The optical communication devices will also provide media conversion between the optical fibre and the copper 10BaseT RJ45 port on the Ethernet switch at each PLC control panel.

At control panels at which more than one PLC is housed, PLCs will be connected to the Ethernet switch. This option may also be exercised at locations where PLCs are installed in separate cabinets that are in very close proximity.

3.8 NETWORK PERFORMANCE AND PROTOCOL

All networks shall use standard Ethernet TCP/IP network protocol. Every network switch and router must at a minimum be capable of providing 10/100 Mbps auto-switching communications rates. Where multiple paths exist, the network devices shall be attached to at least two paths to provide redundancy. At locations where multiple LAN connections are there involving direct connectivity to the SCADA Network, a router shall be installed with the capability to support virtual local area networks (VLANs) to segregate traffic and not impede the control system network performance.

3.9 NETWORK HARDWARE

SCADA Network Ethernet Switches connected to the SCADA network shall be rack mounted and powered from SCADA UPS.

Ethernet switches in the PLC control panels shall support connections to the PLCs and shall

contain a minimum of 3 ports. One port shall be assigned to a portable programming terminal.

The SCADA Nodes, Servers, will be equipped with two Ethernet ports. One port will be connected to the SCADA Network and the other Ethernet port will be required for connection to the PLC Network.

PLC optical network interface devices shall be designed for use in a dual media ring configuration carrying Ethernet traffic. The optical network interface devices shall automatically switch to the standby fibre ring if the primary ring fails.

Optical Communication Modules shall be designed for standalone operation and shall provide media conversion between copper and fibre optic cable, and support Ethernet communication between PLCs and SCADA nodes. Optical Communication Modules shall provide on-line continuous diagnostics of the optical signals, detecting weak signals and channel faults.

4.0 Key Performance Indicators

The Contractor shall demonstrate its ability to reach the performance requirements. Performance tests shall be carried out during the Factory Acceptance Tests.

1. Computer Start Up

Total time for the start-up of a computer, including automatic program load, initialization and database updating, shall not exceed five minutes for critical functions (SCADA, front-ends servers). Automatic restart following a power outage shall also not exceed five minutes.

2. Complete SCADA functionality shall be available within a further five minutes following a start-up or automatic restart of the last computer in the minimum set of computers required to be running to support this functionality. Updates from field devices may extend beyond this time but the full update of the System with data from the field shall not exceed a further five minutes. Thus, a complete restart of the System, including full update from the field, shall not exceed 15 minutes.

3. SCADA System must have System availability of 99.9 %.

The Contractor shall submit with the bid, the System availability values for each major equipment/ component as well as the complete system, supported by availability calculations.

1.0 Minimum Key Personnel requirements:

6.0 Time Schedule

SCADA system

SN.	Description	Cumulative Months from the date of award of works
1.	**Design of Water supply Works**	**06**
2.	**Supply, Execution installation of** SCADA & instrumentation works	**18**
3.	**TESTING AND COMMISSIONING**	24
4.	**O&M of the SCADA System (After commissioning and includes 01 Year DLP).**	**120**

7.0 WARRANTEE

All the software, hardware and instruments / equipment proposed to be supplied and installed for the SCADA system will have an “Extended Warrantee” of **Five (5)** years.

Section VI A:
General Conditions of Contract

Section VI A: General Conditions of Contract

Table of Contents

39 Extension of time for Completion

40 Assignment

41 Contractor's Claim

Appendix A: General Conditions of Admissibility of Escalation

Appendix B: Dispute Resolution during execution of the Contract

1. General Provisions

Sub-Title	Sub-Clause	Provision
Definitions	**1.1**	In the Conditions of Contract (these General Conditions) which include Special Conditions, the following works and expressions shall have the meaning stated as under. Words indicating persons or parties include firms, companies, and other legal entities except where context requires otherwise.
The Contract	**1.1.1**	
	1.1.1.1	**Bill of Quantities (BOQ)** means the priced and completed Bill of Quantities forming part of the Bid. **Activity Schedule** means the various stages of execution of the Works in case of Lump Sum Contract which are linked to payment Schedule.
	1.1.1.2	**Contract** means the document forming the Bid and acceptance thereof and the formal agreement executed between the competent authority on behalf of the Governor of Rajasthan and the Contractor, together with the documents referred to there in including these conditions, the Specifications, designs, Drawings and instructions issued from time to time on Contract and shall be complementary to one another.
	1.1.1.3	**Contract Agreement** means the Contract Agreement referred to in Sub-Clause 1.81 [Signing of the Contract].
	1.1.1.4	**Contract Data** means the pages completed by the Procuring Entity entitled Contract Data which constitute the Special Conditions of the Contract.
	1.1.1.5	**Drawings** means the Drawings of the Works, as included in the Contract and any additional and modified drawings issued by (or on behalf of) the Procuring Entity in accordance with the Contract.
	1.1.1.6	**Letter of Acceptance** means the letter of formal acceptance, signed by the Procuring Entity, including any annexed memoranda comprising agreements between and signed by both Parties. If there is no such Letter of Acceptance, the expression "Letter of Acceptance" means the Contract Agreement and the date of issuing the Letter of Acceptance means the date of signing the Contract Agreement.
	1.1.1.7	**Letter of Technical/Financial Bid** means the document entitled Letter Technical or Letter of Financial bid, which was completed by the Bidder and includes the signed offer to the Procuring Entity for the Works.
	1.1.1.8	**Risk and Cost means** when the Contractor fails to complete the Contract despite due notices, the procuring entity may terminate the Contract with full 10% compensation and/ or measure the acceptable work done and get the balance work of the BOQ/ Activity Schedule carried out at the risk and cost of the Contractor and the difference of cost at which the balance work is carried out through the Department/ Organisation or another agency is debited to the Contractor.
	1.1.1.9	**Schedules** means the document(s) entitled Schedules, completed by the Contractor and submitted with the letter of Bid, as included in the Contract. Such documents may include the Bill of Quantities, data, lists and Schedules of rates and /or prices.
	1.1.1.10	**Specifications** means the BIS, IRC, and other Code Specification of the Works followed by relevant Department of the Government of India/State Government and/or included in the Contract and any modification or addition made or approved by the Engineer-in-Charge.
	1.1.1.11	**Technical/ Financial Bid** means the Letter of Technical or Financial Bid and all other documents which the Bidder submitted with the Letter of Technical or Financial Bid,as included in the Contract.

	1.1.1.12	**Scope of Facilities** 1. Unless otherwise expressly limited in the Employer's Requirements, the Contractor's obligations cover the provision of all Plant and the performance of all Installation Services required for the design, the manufacture (including procurement, quality assurance, construction, installation, associated civil works, pre-commissioning and delivery) of the Plant and the installation, completion, and commissioning of the Facilities in accordance with the plans, procedures, specifications, drawings, codes, and any other documents as specified in the section Employer's Requirements. Such specifications include, but are not limited to, the provision of supervision and engineering services; the supply of labor, materials, equipment, spare parts (as specified in GCC Subclause 3 below) and accessories; Contractor's Equipment; construction utilities and supplies; temporary materials, structures, and facilities; transportation (including, without limitation, unloading and hauling to, from and at the Site); and storage, except for those supplies, works, and services that will be provided or performed by the Employer, as set forth in the Appendix (Scope of Works and Supply by the Employer) to the Contract Agreement. 2. The Contractor shall, unless specifically excluded in the Contract, perform all such work and/or supply all such items and materials not specifically mentioned in the Contract but that can be reasonably inferred from the Contract as being required for attaining Completion of the Facilities as if such work and/or items and materials were expressly mentioned in the Contract. 3. In addition to the supply of Mandatory Spare Parts included in the Contract, the Contractor agrees to supply spare parts required for the operation and maintenance of the Facilities for the period specified in the SCC and the provisions, if any, specified in the SCC. However, the identity, specifications, and quantities of such spare parts and the terms and conditions relating to the supply thereof are to be agreed between the Employer and the Contractor, and the price of such spare parts shall be that given in Price Schedule, which shall be added to the Contract Price. The price of such spare parts shall include the purchase price therefore and other costs and expenses (including the Contractor's fees) relating to the supply of spare parts.
Parties and Persons	**1.1.2**	
	1.1.2.1	**Party**: means the Procuring Entity or the Contractor, or both as the context requires.
	1.1.2.2	**Contractor** shall mean the individual, firm or company, whether incorporate or not undertaking the Works and shall include the legal or authorised representative of such individual or the persons composing such firm or company or the successors of such firm or company and the permitted as signees of such individual, firm or company.
	1.1.2.3	**Contractor's Personnel** means the Contractor and Contractor's Representative and all personnel whom the Contractor utilizes on Site, who may include the staff, labour and other employees of the Contractor and of each Subcontractor; and any other personnel assisting the Contractor in the execution of the Works. All communications addressed to the Contractor can be handed over at site to the Contractor's personnel.
	1.1.2.4	**Contractor's Representative** means the person named by the Contractor in the Contract or appointed from time to time by the Contractor under Sub-Clause 4.5 [Contractor's Representative], who acts on behalf of the Contractor.
	1.1.2.5	**Engineer-in-Charge or Engineer** means the Divisional officer / Executive Engineer who shall be in-charge of the Works and who shall sign the Contract on behalf of the Governor of Rajasthan and who shall be responsible for

		supervising the Contract, administering the Contract, certifying payments due to the Contractor, issuing and valuing Variations to the Contract, awarding extension of time, valuing the Compensation events, etc.
	1.1.2.6	The **Procuring Entity or PE** means the Party who employs the Contractor to carry out the Works.
	1.1.2.7	**Procuring Entity's Personnel** means the Engineer-in-Charge, the assistants referred to in Sub-Clause 3.2 [Delegation by the Engineer-in-Charge] and all other staff, labour and other employees of the Engineer-in-Charge and of the Procuring Entity; and any other personnel notified to the Contractor, by the Procuring Entity or the Engineer-in-Charge, as Procuring Entity's Personnel.
	1.1.2.8	**Subcontractor** means any person / firm named in the Bid /Contract and approved by the Engineer-in-Charge as a Subcontractor, or any person appointed and approved as a Subcontractor subsequently, for a part of the Works; and the legal successors in title to each of these persons/ firms.
Dates, tests and periods of completion	**1.1.3**	
	1.1.3.1	**Base Date** means the date28Dayspriorto the last date specified for submission of the Bid.
	1.1.3.2	**Commencement/ *start* Date** means the date specified under Sub-Clause 8.3.1 [Commencement of Works].
	1.1.3.3	A **Defect** is any part of the Works not completed in accordance with the approved specifications, designs and/ or drawings of the Contract.
	1.1.3.4	The **Defect Liability Certificate** is the certificate issued by Engineer-in-Charge after Defect Liability Period has ended and upon correction of Defects *pointed out* by the Engineer-in-Charge.
	1.1.3.5	The **Defect Liability Period** will be decided by the Department/ Organisation depending on nature of the Works, from the date of completion of the Works and shall be mentioned in the Contract Data.
	1.1.3.6	**Defects Notification Period** means the period for notifying Defects in the Works or a Section(as the case may be) under Sub-Clause 13.2 [Completion of Outstanding Work and Remedying Defects], which extends over twelve Months except if otherwise stated in the Contract Data (with any extension under Sub-Clause 13.4 [Extension of Defects Notification Period], calculated from the date on which the Works or Section is completed as certified under Sub-Clause 12.1 [Taking Over of the Works and Sections].
	1.1.3.7	**Performance Certificate** means a certificate issued under Sub-Clause 13.10 [Performance Certificate].
	1.1.3.8	**Taking-Over Certificate** means a certificate issued under Sub-Clause 12.1 [Taking Over of the Works and Sections].
	1.1.3.9	**Tests on Completion** means the tests which are specified in the Contract or agreed by both Parties or instructed as a Variation, and which are carried out under Clause 11 [Tests on Completion]before the Works or a Section (as the case may be) are taken over by the Procuring Entity.
	1.1.3.10	**Tests after Completion** means the tests (if any) which are specified in the Contract and which are carried out in accordance with the Specification after the Works or a Section (as the case may be) is taken over by the Procuring Entity.
	1.1.3.11	The **Intended Completion Date** is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the Contract Data. The Intended Completion Date may be revised only by the Engineer-in Charge by issuing an extension of time.
	1.1.3.12	**Time for Completion** means the time for completing the Works or a section (as the case may be) under Sub-Clause 8.4 [Time for Completion], as stated in the Contract Data (with any extension under Sub-Clause 8.6 [Extension of Time for Completion], calculated from Commencement Date.

	1.1.3.13	**Day means** calendar Day; **Year** means a period of 365 Days.
Money and Payments	**1.1.4**	
	1.1.4.1	**Accepted Contract Amount** means the amount accepted in the Letter of Acceptance for execution and completion of the Works and remedying of any defects and maintaining the Works, if stated in the Contract.
	1.1.4.2	**Cost** means all expenditure reasonably incurred (or to be incurred) by the Contractor, whether on or off the Site, including overhead and similar charges, but does not include profit.
	1.1.4.3	**Final Payment Certificate** means the Payment Certificate issued under Sub-Clause 15.9 [Issue of Final Completion Certificate].
	1.1.4.4	**Final Statement** means the statement defined in Sub-Clause 15.10 [Final Statement of Payments].
	1.1.4.5	**Interim Payment Certificate** means a Payment Certificate issued under Sub-Clause 15.5 [Issue of Interim Payment Certificate], other than the Final Payment Certificate.
	1.1.4.6	**Market Rate of an item** shall be the current rate as decided by the Engineer-in Charge on the basis of the Cost of Materials and Labour at the Site where the work is to be executed for a variation item.
	1.1.4.7	**Payment Certificate** means a Payment Certificate issued under Clause 15 [Contract Price, Payment and Lien].
	1.1.4.8	**Provisional sums/ Lump sums** means a sum (if any) which is specified in the Contract as a provisional sum, for the execution of any part of the Works or for supply of Plant, Materials or services under Sub-Clause 9.6 [Provisional Sums]. These are also moneys provided in the estimate of the project to pay for unforeseen / un-quantified items. It may also include lump sum provided in the estimate/ BOQ for unforeseen items to be paid after approval of analysis of rates of such items and charges payable to Government agencies or the contractor for approvals, service connections and extensions of services from the supply lines etc., as the case may be.
	1.1.4.9	**Performance Security** means **a**n amount as percentage of the Accepted Contract Price deposited in the form of Bank Guaranteed or any other prescribed form deposited by the Contractor as a security for due performance of the Contract.
Works and Materials	**1.1.5**	
	1.1.5.1	**Materials** are all supplies, including consumables, used by the Contractor for consumption in the Works.
	1.1.5.2	**Permanent Works** means the Permanent Works to be executed by the Contractor under the Contract. These works shall have a defined designed life and durability.
	1.1.5.3	**Plant** means the apparatus, machinery and other equipment intended to form or forming part of the Permanent Works,
	1.1.5.4	**Scope of work** shall cover execution of all aspects of the Works as per the Contract.
	1.1.5.5	**Section** means apart from the Works specified in the Contract Data as a Section (if any).
	1.1.5.6	**Specifications** means the Specification *(BIS, IRC etc. or specifications approved by the department or others)* of the Works included in the Contract and any modification or addition made or approved by the Engineer-in Charge.
	1.1.5.7	**Temporary Works** are Works designed, constructed, installed, and removed by the Contractor which are needed for construction or installation of the Works.
	1.1.5.8	**Work or Works** shall, unless there is something either in the subject or context repugnant to such construction, be construed and taken to mean the Works by virtue of the Contract contracted to be executed whether temporary or permanent

		and whether original, altered, substituted or additional works.
Others	**1.1.6**	
Interpretation	**1.1.6.1**	**Act m**eans the Rajasthan Transparency in Public Procurement Act, 2012.
	1.1.6.2	**Contractor's documents** are the bids (technical and financial) submitted software, bills, reports, drawings, designs, letters/ communications, test results, etc., submitted by the Contractor to the Procurement Entity in connection with the Contract.
	1.1.6.3	**Department** means any Department of Government of Rajasthan which invite Bids on behalf of Governor of Rajasthan as specified in Contract Data.
	1.1.6.4	**Field laboratory** means the Contractor's equipped laboratory provided with equipment, experienced personnel, and consumables, books of specifications, codes for use on quality testing /inspections on the works.
	1.1.6.5	**Force Majeure** is defined in Sub-Clause 19.1 [Definition of Force Majeure].
	1.1.6.6	**Government/ Governor of Rajasthan** means the State Government of Rajasthan/ Governor of Rajasthan
	1.1.6.7	**Laws** means all the national or the state legislations, statutes, ordinances and other laws, and regulations and by-laws of India and Rajasthan and any legally constituted public authority.
	1.1.6.8	**Procuring Entity's Equipment** means the apparatus, machinery and vehicles (if any) made available by the Procuring Entity on hire for the use of the Contractor in the execution of the Works, as stated in the Specifications; but does not include Plant which has not been taken over by the Procuring Entity.
	1.1.6.9	**Rules** means the Rajasthan Transparency in Public Procurement Rules, 2013
	1.1.6.10	**Site** shall mean land and/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.
	1.1.6.11	**Site office** means a suitable covered all weather usable space built by the Contractor at Site of Works at his cost for use by him and the Procuring Entity.
	1.1.6.12	**Unforeseeable** means not reasonably foreseeable by an experienced Contractor by the Base Date.
	1.1.6.13	**Variations** mean any change to the Works, which is instructed or approved as a variation under Clause 9 [Deviations, Variations and Adjustments].
	1.2	In the Contract, except where the context requires otherwise (a) words indicating one gender include all genders; (b) words indicating the singular also include the plural and (c) words indicating the plural also include the singular; (d) provisions including the word "agree", "agreed" or "agreement" require the agreement to be recorded in writing; (e) "written" or "in writing" means hand-written, type-written, printed or electronically made, and resulting in a permanent record; (f) the word "tender" is synonymous with "bid" and "tenderer" with "bidder" and the words "tender document" with "bidding document". The marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions.
Communications	**1.3**	Wherever these Conditions provide for the giving or issuing of approvals, certificates, consents, determinations, notices, requests and discharges, by one party to the other, these communications shall be: i. in writing and delivered by hand against receipt, sent by mail or courier, or transmitted using any of the agreed systems of electronic transmission as stated in the Contract Data; and ii. delivered sent or transmitted to the address for the recipient'sCommunications as stated in the Contract Data. However: a) if the recipient gives notice of another address, communications shall

		thereafter be delivered accordingly; and b) if the recipient has not stated otherwise when're questing an approval or consent, it may be sent to the address from which the request was issued. Approvals, certificates, consents and determinations shall not be unreasonably withheld or delayed. When a certificate is issued to a Party, the certifier shall send a copy to the other Party. When a notice is issued to a Party, by the other Party or the Engineer-in-Charge, a copy shall be sent to the Engineer-in-Charge or the other Party, as the case may be.
Law and language	**1.4**	The Contract shall be governed by the laws of India and the State of Rajasthan. The ruling language of the Contract shall be English or that stated in the Special Conditions of Contract.
Works to be carried out	**1.5**	The Works to be carried out under the Contract shall, except as otherwise provided in these conditions, include all labour, materials, equipment, tools, plants, testing and quality assurance, and transport which may be required in preparation of and doing in the full and entire execution and completion of the Works. The descriptions given in the Schedule of Quantities (Activity Schedule in case of Lump Sum Contract) 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 Labour necessary in and for the full and entire execution and completion of the Works as aforesaid in accordance with good practice and recognized principles to deliver a work of specified quality and durability conforming to designs, drawings etc. The Works include clearance, levelling and dressing of Site within a distance of 15 meters of the work site on all sides except where the building adjoins another building.
Sufficiency of Tender/ Bid	**1.6**	The Contractor shall be deemed to have satisfied himself before bidding as to the correctness and sufficiency of his Bid 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. He shall also be responsible for satisfying himself on the completeness of the documents /data provided by the Procuring Entity. He shall not raise any objections or deficiencies or inaccuracies in such documents.
Discrepancies and adjustment of errors	**1.7.1**	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.
	1.7.2	In the case of discrepancy between the Bill of Quantities, the Specifications and/or the Drawings, the following order of preference shall be observed: • Description of Bill of Quantities • Particular *detailed* Specification and Special Condition, if any • Drawings / Designs • IRC / MORT&H , ASTHO Specification, if required • Indian Standard Specifications or B.I.S.
	1.7.3	If there are varying or conflicting provisions made in any one document forming part of the Contract, the Procuring Entity shall be the deciding authority with regard to the intention of the document and his decision shall be final and binding on the Contractor.
	1.7.4	Any error in description, quantity or rate in Bill of Quantities or any omission therefore shall not impair the legal validity of the Contract or release the Contractor from the responsibility of execution of the whole or part of the Works comprised there in according to Drawings and Specifications or from any of his obligations under the Contract.

Signing of the Contract	**1.8.1**	The successful Bidder, after submitting the performance guaranteei.e.within15 Days of receipt of Notification of Award or as specified in the Contract Data, shall attend the office of the Procurement Entity / Engineer- in-charge for authentication, signing and completion of the Contract document and execute the agreement consisting of: The notice inviting Bid, all the documents including Drawings, if any, forming the Bidding Document as issued at the time of invitation of bids and acceptance thereof together with any correspondence leading there to, Standard Forms consisting of various standard Sub-Clauses with corrections up to the date stipulated in Contract Data along with annexure thereto and drawings etc. The Costs of stamp duties and similar charges (if any) imposed by Law in connection with entry in to the Contract Agreement shall be borne by the Contractor.
Signed copy of Contract Document to be given to Contractor	**1.8.2**	The Contractor shall be furnished, free of Cost one signed copy of the Contract Documents together with all Drawings except standard Specifications (BIS or IRC or others), Schedule of Rates and such other printed and published documents, which shall be procured by the Contractor at his cost. *These documents shall be deemed to be part of the Contract. These shall be kept in the Site office.* None of these documents shall be used for any purpose other than that of this Contract.
Conditions of the Contract	**1.8.3**	The Contract shall be governed by the General Conditions of Contract (GCC). The Special Conditions of Contract (SCC)/ Contract Data, wherever applicable, shall supersede/ clarify the GCC to the extent specified.
Priority of Documents	**1.8.4**	The documents forming the Contract are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence: (a) the Contract Agreement, (b) the Letter of Acceptance, (c) the Technical Bid and Financial Bid along with the letters of the Technical Bid and Financial Bid (d) the Contract Data/ Special Conditions of Contract, (e) the General Conditions of Contract, (f) the Scope of Work &Specifications, (g) the Drawings, (h) the Instructions to Bidders, (i) the Notice Inviting Bids, and (j) the Schedules and any other documents forming part of the Contract. If an ambiguity or discrepancy is found in the documents, the Engineer-in-Charge shall issue any necessary clarification or instruction.
Personnel	**1.9.1**	The Contractor shall employ the key personnel named in the Schedule of Key Personnel as referred to in the qualification criteria to carry out the functions stated in the Schedule or other personnel approved by the Engineer-in-Charge. The Engineer-in-Charge will approve any proposed replacement of key personnel only if their qualifications, abilities, and relevant experiences are substantially equal to or better than those of the personnel listed in the Schedule.
	1.9.2	If the Engineer-in-Charge asks the Contractor to remove a person who is a member of the Contractor's staff or his work force stating reasons, the Contractor shall ensure that the person leaves the Site within seven Days and has no further connection with the work in the Contract.
Procuring Entity's Risks	**1.10**	The Procuring Entity is responsible for the excepted risks which are : (a) In so far as they directly affect the execution of the Works in India, the risks of war, hostilities, invasion, act of foreign enemies, rebellion, revolution, insurrection or military or usurped power, civil war, riot commotion or disorder (unless restricted to the Contractor's employees), and contamination from any nuclear fuel or nuclear waste or radioactive toxic explosive, or (b) A cause due solely to the design of the Works, other than the Contractor's

		design.
Contractor's Risks	**1.11**	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 Procuring Entity's risks are the responsibility of the Contractor.
Procuring Entity's use of Contractor's documents	**1.12**	As between the Parties, the Contractor shall retain the copy right and other intellectual property rights in the Contractor's Documents and other design documents made by (or on behalf of)the Contractor. The Contractor shall be deemed (by signing the Contract) to give to the Procuring Entity a non-terminable transferable non- exclusive royalty-free license to copy, use and communicate the Contractor's Documents, including making and using modifications of them. This license shall: i. Apply throughout the actual or intended working life (whichever is longer) of the relevant parts of the Works, ii. Entitle any person in proper possession of the relevant part of the Works to copy, use and communicate the Contractor's Documents for the purposes of completing, operating, maintaining, altering, adjusting, repairing and demolishing the Works, and in the case of Contractor's Documents which are in the form of computer programs and other software, permit their use on any computer on the Site and other places as envisaged by the Contract, including replacements of any computers supplied by the Contractor. iii. The Contractor's Documents and other design documents made by (or on behalf of) the Contractor shall not, without the Contractor's consent, be used, copied or communicated to a third Party by (or on behalf of) the Procuring Entity for purposes other than those permitted under this Sub-Clause.
Contractor's use of Procuring Entity's Documents	**1.13**	As between the Parties, the Procuring Entity shall retain the copyright and other intellectual property rights in the Specification, the Drawings and other documents made by (or on behalf of) the Procuring Entity. The Contractor may, at his Cost, copy, use, and obtain communication of these documents for the purposes of the Contract. They shall not, without the Procuring Entity's consent, be copied, used or communicated to a third Party by the Contractor, except as necessary for the purposes of the Contract.
Care and Supply of documents	**1.14**	The approved Specification, Designs and Drawings shall be in the custody and care of the Procuring Entity. Unless otherwise stated in the Contract, one copy of the Contract and of each subsequent Drawing shall be supplied to the Contractor, who may make further copies at his Cost. Each of the Contractor's Documents shall be in the custody and care of the Contractor, unless and until taken over by the Procuring Entity. Unless otherwise stated in the Contract, the Contractor shall supply to the Engineer-in-Charge four copies of each of the Contractor's Documents. The Contractor shall keep, on the Site, a copy of the Contract, publications named in the Specification, the Contractor's Documents (if any), the Drawings and Variations and other communications given under the Contract. The Procuring Entity's Personnel shall have the right of access to all these documents at all reasonable times. If a Party becomes aware of an error or Defect in a document which was prepared for use in executing the Works, the Party shall promptly give notice to the other Party of such error or Defect.
Delays in issuing drawings or instructions.	**1.15**	The Contractor shall give notice to the Engineer-in-Charge whenever the Works are likely to be delayed or disrupted if any necessary Drawing or instruction is not issued to the Contractor with in a particular time, which shall be reasonable. The notice shall include details of the necessary Drawing or instruction, details of why and by when it should have been issued, and the nature and amount of the delay or disruption likely to be suffered if it is late. If the Contractor suffers delay and/or incurs Cost as a result of a failure of the Engineer-in-Charge to issue the notified Drawing or instruction within a time which

		is reasonable and is specified in the notice with supporting details, the Contractor shall give a further notice to the Engineer-in-Charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion], However, if and to the extent that the Engineer-in-Charge's failure was caused by any error or delay by the Contractor, including an error in, r delay in the submission of, any of the Contractor's Documents, the Contractor shall not be entitled to such extension of time,
Confidential Details	**1.16**	The Contractor's and the Procuring Entity's Personnel shall not disclose all such confidential and other information as may be reasonably required in order to verify compliance with the Contract and allow its proper implementation. Each of them shall treat the details of the Contract as private and confidential, except to the extent necessary to carry out their respective obligations under the Contract or to comply with applicable Laws. Each of them shall not publish or disclose any particulars of the Works prepared by the other Party without the previous agreement of the other Party. However, the Contractor shall be permitted to disclose any publicly available information, or information otherwise required to establish his qualifications to compete for other projects.
2. The Procuring Entity		
Right of Access to the Site	**2.1**	The Procuring Entity shall give the Contractor right of access to, and possession of at least 80% of the Site within 30 days of signing of the Contract or within the time specified in the Special Conditions of Contract (SCC). If under the Contract the Procuring Entity is required to give to the Contractor possession of any foundation, structure, plant or means of access, the Procuring Entity shall do so in the time and manner stated in the Specification. However, the Procuring Entity may withhold any such right or possession until the Performance Security has been received. If the Contractor suffers delay as a result of a failure by the Procuring Entity to give any such right or possession within such time, the Contractor shall give notice to the Engineer-in-charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to an extension of time for any such delay, if completion is or will be delayed, After receiving this notice, the Engineer-in-charge shall proceed to agree or determine these matters However, if and to the extent that the Procuring Entity's failure was caused by any error or delay by the Contractor, including an error in, or delay in the submission of, any of the Contractor's Documents, the Contractor shall not be entitled to such extension of time.
	2.2	The right and possession may not be exclusive to the Contractor.
Assistance by Procuring Entity	**2.3**	The Procuring Entity shall provide, at the request of the Contractor, such reasonable assistance as to allow the Contractor to obtain expeditiously any permits, licenses or approvals which the Contractor is required to obtain : i. For the delivery of Goods, including clearance through customs, and ii. For the export of Contractor's Equipment when it is removed from the Site.
Procuring Entity's Personnel	**2.4**	The Procuring Entity shall be responsible for ensuring that the Procuring Entity's Personnel and the Procuring Entity's other Contractors on the Site, co-operate with the Contractor's efforts under Sub-Clause 4.7[Co-operation],and take actions similar to those which the Contractor is required to take under Sub-Clause 4.8[Safety Procedures]and under Sub-Clause 4.17 [Protection of the Environment]
Procuring Entity's Claims	**2.5**	If the Procuring Entity considers himself to be entitled to any payment under any Sub-Clause of these Conditions or otherwise in connection with the Contract, and/or to any extension of the Defects Liability Period, the Procuring Entity or the Engineer-in- charge shall give notice and particulars to the Contractor. However,

		notice is not required for payments due under Sub-Clause 4.18 [Electricity, Water and Gas], under Sub-Clause 4.19 [Issue of Procuring Entity's Equipment and Materials], or for other services requested by the Contractor. The notice shall be given as soon as practicable and no longer than28 Days after the Procuring Entity became aware, or should have become aware, of the event or circumstances giving rise to the claim. A notice relating to any extension of the Defects Notification Period shall be given 28 days before the expiry of such period. The particulars shall specify the Sub-Clause or other basis of the claim, and shall include substantiation of the amount and/or extension Defects Notification Period to which the Procuring Entity considers himself to be entitled in connection with the Contract. The Engineer-in-charge shall then proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the amount (if any) which the Procuring Entity is entitled to be paid by the Contractor, and/or the extension (if any) of the Defects Notification Period in accordance with Sub-Clause 13.4 [Extension of Defects Notification Period]. This amount may be included as a deduction in the Contract Price and Payment Certificates. The Procuring Entity shall be entitled to set off against or make any deduction from an amount certified in a Payment Certificate, or to otherwise claim against the Contractor, in accordance with this Sub-Clause.
Quality Control	**2.6**	The Procuring Entity shall have the right to exercise proper Quality Control measures. The Contractor shall provide a fully equipped field laboratory, testing personnel, consumables and other assistance at his cost to conduct such tests. The Quality Control shall be in three tiers : i) tier one by the Contractor's Engineers to the specified frequency, ii) by the Engineer-in-Charge's personnel to conform the quality and acceptance of the work and iii) by the Technical Examiner's organisation or such other independent bodies of State Government/ the Department/ Organisation or QCI approved Third Party Quality Inspection Agency. The work shall have to be completed to conform to the specifications and shall be acceptable only after rectification of deficient /defective works as per 'Non Conformance Reports', if any, issued by the above mentioned agency or the Engineer-in-Charge.
3. Engineer-in-Charge		
Duties and Responsibilities	**3.1.1**	The Superintending Engineer (SE) of the concerned Division will function as the Engineer-in-Charge for the purpose of the Contract or the Procuring Entity shall appoint another engineer as the Engineer-in-charge, as specified in the Contract Data, who shall carry out the duties assigned to him in the Contract and ensure execution of works as per approved drawings, designs, specifications etc.. The Engineer-in-charge's staff shall include suitably qualified Engineers and other professionals who are competent to carry out these duties. The Engineer-in-charge shall have no authority to amend the Contract. The Engineer-in-charge may exercise the authority attributable to the Engineer-in-charge as specified in or necessarily to be implied from the Contract. If the Engineer-in- charge is required to obtain the approval of the Procuring Entity before exercising a specified authority, he shall have to obtain that approval.
	3.1.2	The Procuring Entity shall promptly inform the Contractor of any change to the authority attributed to the Engineer-in-charge. However, whenever the Engineer-in-charge exercises a specified authority for which the Procuring Entity's approval is required, then (for the purposes of the Contract) the Procuring Entity shall be deemed to have given approval. Except as otherwise stated in these Conditions: i. whenever carrying out duties or exercising authority, specified in or implied by the Contract, the Engineer- in-charge shall be deemed to act for the Procuring Entity; ii. the Engineer-in-charge has no authority to relieve either Party of any duties,

		obligations or responsibilities under the Contract; and iii. any approval, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test, or similar act by the Engineer-in-charge (including absence of disapproval) shall not relieve the Contractor from any responsibility he has under the Contract, including responsibility for errors, omissions, discrepancies, quality of works and non-compliances to specifications/ instructions of the Engineer-in-charge /Procuring Entity. iv. Any act by the Engineer-in-charge in response to a Contractor's request except otherwise expressly specified shall be notified in writing to the Contractor within 28 Days of receipt. The Engineer-in-charge shall obtain the specific approval of the competent authority before taking action under the following Sub-Clauses of these Conditions and other Sub-Clauses, if specified in the Contract Data: i. Sub-Clause 4.12 [Unforeseeable Physical Conditions] agreeing or determining an extension of time and/or additional Cost. ii. Sub-Clause 9.1 [Right to Vary]: Instructing a Variation, except; (a) In an emergency situation as determined by the Engineer-in-charge, or (b) If such a Variation would increase the Accepted Contract Amount by less than the percentage specified in the Contract Data. iii. Approving a proposal for Variation submitted by the Contract or in accordance with Sub-Clause 9.1 [Right to Vary] or Sub-Clause 9.3 [Value Engineering]. Notwithstanding the obligation, asset out above, to obtain approval, if, in the opinion of the Engineer-in-charge, an emergency occurs affecting the safety of life or of the Works /workmen or of adjoining property, he may, without relieving the Contractor of any of his duties and responsibility under the Contract, instruct the Contract or to execute all such work or to do all such things as may, in the opinion of the Engineer-in-charge, be necessary to abate or reduce the risk. The Contract or shall forth with comply, despite the absence of approval of the competent authority, with any such instruction of the Engineer-in-charge. The Engineer-in-charge shall determine *(after due approval from the competent authority)* an addition to the Contract Price, in respect of such instruction, in accordance with Clause 9 [Deviations, Variations and Adjustments] and shall notify the Contract or accordingly, with a copy to the Procuring Entity.
Delegation by Engineer- in-Charge	**3.2**	The Engineer-in-charge may from time to time assign duties and delegate authority to assistants and may also revoke such assign mentor delegation. These assistants may include a resident Engineer, and/or independent inspectors appointed to inspect and/or test items of works and/or Materials. The assignment, delegation or revocation shall be in writing and shall not take effect until copies have been received by both Parties. However, unless otherwise agreed by both Parties, the Engineer-in-charge shall not delegate the authority to determine any matter in accordance with Sub-Clause 3 .5 [Determinations] Each assistant, to whom duties have been assigned or authority has been delegated, shall only be authorized to issue instructions to the Contractor to the extent defined by the delegation. Any approval, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test, or similar act by an assistant, in accordance with the delegation, shall have the same effect as though the act had been an act of the Engineer-in-charge. However: i. any failure to disapprove any work, Plant or Materials shall not constitute approval, and shall therefore not prejudice the right of the Engineer-in-charge to reject the work, Plant or Materials; ii. if the Contractor questions any determination or instruction of an assistant, the Contractor may refer the matter to the Engineer-in-charge, who shall promptly confirm, reverse or vary the determination or instruction.

Instruction of the Engineer-in-Charge	**3.3**	The Engineer-in-charge may issue to the Contractor (at any time) instructions and additional or modified Drawings which may be necessary for the execution of the Works and the remedying of any Defects, all in accordance with the Contract. The Contractor shall only take instructions from the Engineer-in-charge, or from an assistant to whom the appropriate authority has been delegated under Sub-Clause 3.2. If an instruction constitutes a Variation, Clause 9[Deviations, Variations and Adjustments] shall apply. The Contractor shall comply with the instructions given by the Engineer-in-charge or delegated assistant, on any matter related to the Contract. Whenever practicable, their instructions shall be given in writing. If the Engineer-in-charge or a delegated assistant: i. gives an oral instruction, ii. receives a written confirmation of the instruction, from (or on behalf of)the Contractor, within two working Days after giving the instruction, and iii. does not reply by issuing a written rejection and/or instruction within two working Days after receiving the confirmation, then the confirmation shall constitute the written instruction of the Engineer-in-charge or delegated assistant(as the case may be).
Replacement of Engineer-in-Charge	**3.4**	If the Procuring Entity intends to replace the Engineer-in-charge, the Procuring Entity shall inform the contractor by a notice before the intended date of replacement, the name and contact details of the intended replacement of the Engineer-in-charge.
Determinations	**3.5**	Whenever these Conditions provide that the Engineer-in-charge shall proceed in accordance with this Sub-Clause 3.5 to agree or determine any matter like variations, extensions of time, responsibilities / valuation for loss and or damage to works etc., the Engineer-in-charge shall peruse the Contract, Specifications, Codes and consult the Contractor in an endeavour to reach an agreement. If an agreement is not reached, the Engineer-in-charge shall make a fair determination in accordance with the Contract, taking due regard of all relevant circumstances. The Engineer-in-charge shall give notice to the Contractor of each agreement or determination, with supporting particulars, within 28 Days from the likely date of implementation of such agreement or determination and obtain receipt of the corresponding claim or request except when otherwise specified. The Contractor shall give effect to each determination unless and until revised under Clause 21[Claims, Disputes and Arbitration].
Minutes of Meeting	**3.6**	The Engineer-in-charge may require the Contractor to attend a progress review / or quality assurance/ design review meeting during execution of the Works. The Engineer- in-charge shall record the minutes of the meeting and provide a copy within 7 days to the Contractor for compliance. These minutes will be a part of evidence in case of request for extension of time or variation or punitive action against the Contractor as per terms of the Contract. In case the issue of minutes is delayed, the Contractor may issue the record note of discussions and decisions taken in the meeting for record and confirmation by the Engineer-in Charge. These shall be treated as confirmed if not denied within 15 days by the Engineer-in-Charge.
4. The Contractor		
Cost of Remedying Defects	**13.12**	All work referred to in Sub-Clause 13.11 above [Completion of Outstanding Work and Remedying Defects] shall be executed at the risk and cost of the Contractor, if and to the extent that the work is attributable to: i. any design for which the Contractor is responsible, ii. Plant, Materials or workmanship not being in accordance with the Contract, or iii. Failure by the Contractor to comply with any other obligation.

General Obligations and Contractor's personnel.	**4.1.1**	The Contractor shall design, prepare drawings (to the extent specified in the Contract), execute as per specifications and complete the Works in accordance with the Contract and with the Engineer-in-Charge's instructions, and shall remedy any Defects in the Works. The Contractor shall provide the Plant and Contractor's Documents specified in the Contract, and all Contractor's Personnel, Goods, consumables and other things and services, whether of a temporary or permanent nature, required in and for this design, execution, completion and remedying of Defects.
	4.1.2	The Contractor shall be responsible for the adequacy, stability and safety of all Site operations and of all methods of construction. Except to the extent specified in the Contract, the Contractor shall be responsible for all Contractor's Documents, Temporary Works, and such design of each item of works, Plant and Materials as is required for the item to be in accordance with the specifications for items of Contract, and shall not otherwise be responsible for the design or Specification of the Permanent Works.
	4.1.3	The Contractor shall deploy experienced and competent personnel to execute the works. The quality of workmanship has to be as specified. Personnel not found capable of good workmanship shall be removed and replaced with better workman.
	4.1.4	The Contractor shall, whenever required by the Engineer-in-charge, submit details of the arrangements and methods which the Contract or proposes to adopt for the execution of the Works. He shall also be responsible for the safety of works and personnel at the site and shall submit a safety execution plan (as per relevant code for safety at construction site) for the approval by the Engineer-in-charge. No significant alteration to these arrangements and methods shall be made without this having previously been approved by the Engineer-in-charge. He shall also comply with the requirements of the mitigations of the Environmental impacts of the execution of works.
	4.1.5	If the Contract specifies that the Contract or shall design any part of the Permanent Works, then unless otherwise stated in the Special Conditions of Contract: i. the Contractor shall submit to the Engineer-in-charge the Contractor's Documents for this part in accordance with the procedures specified in the Contract. ii. these Contractor's Documents shall be in accordance with the Specification an Drawings, shall be written in the language for communications defined in the Sub-Clause 1.4 [Law and Language] and shall include additional information required by the Engineer-in-charge to add to the Drawings for co-ordination of each Party's designs; iii. the Contractor shall be responsible for this part and it shall, when the Works are completed, be fit for such purposes for which the part is intended as are specified in the Contract; and iv. prior to the commencement of the Tests on Completion, the Contractor shall submit to the Engineer-in-charge the "as-built" drawings, designs and documents and, if applicable, operation and maintenance manuals in accordance with the Specification and insufficient detail for the Procuring Entity to operate, maintain, dismantle, reassemble, adjust and repair all parts of the Works. Such part shall not be considered to be completed for the purposes of taking-over under Clause 12 [Taking Over of the Works and Sections] until these documents and manuals have been submitted to the Engineer-in-charge.
	4.1.6	The Contractor shall allow the Engineer-in-charge and any person authorized by the Engineer-in-charge access to the Site, to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where Materials or plant are being installed / assembled for the

		Works. The contractor may satisfy himself regarding site, acquisition of land, approach roads etc.
	4.1.7	The liability, if any, on account of quarry fees, royalties, octroi, service tax, and any other taxes and duties in respect of materials actually consumed on public work shall be borne by the Contractor.
	4.1.8	The cost of all water / power connections necessary for the execution of the Works and the cost of water consumed and hire charges of meters and the cost of electricity consumed in connection with the execution of the Works shall be paid by the Contractor except where otherwise specifically indicated. He shall also be responsible for environment mitigated disposal of waste water released during execution.
Compliance with the Code of Integrity	**4.2.1**	The Contractor is bound by the provisions of the Code of Integrity stipulated in the Act , the Rules and specified in ITB Sub-Clause 1.3 [Code of Integrity] and refrain himself from corrupt, fraudulent, coercive and collusive practices which are defined as below: a) "corrupt practice" means the offering, giving, receiving, or soliciting, directly or indirectly, anything of value to influence improperly the actions of another party; b) "fraudulent practice" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation; c) "coercive practice" means impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the action sofa party; d) "collusive practice" means an arrangement between two or more parties designed to achieve an improper purpose, including influencing improperly the actions of another party.
	4.2.2	The Procuring Entity shall take legal action against the Contractor, if it breaches any provisions of the Code of Integrity, under Section 11(3), 46 and chapter IV of the Act.
	4.2.3	The Contractor shall permit the Procuring Entity to inspect the Contractor's accounts and records relating to the performance of the Contract and to have them audited by auditors appointed by the Procuring Entity, if so required by the Procuring Entity.
Performance Security	**4.3.1**	The Contractor shall have the option to furnish a Performance Security @ 10% of the Contract value, in Indian Rupees, in one of the following forms *[strike out which is not applicable]*: i. Deposit through **eGRAS**; or ii. **Bank Draft** or **Banker's Cheque** of a Scheduled Bank in India; or iii. **National Savings Certificates** and any other script/ instrument under National Savings Schemes for promotion of small savings issued by a Post Office in Rajasthan, if the same can be pledged under the relevant rules. They shall be accepted at their surrender value at the time of Bid and formally transferred in the name of the Procuring Entity with the approval of Head Post Master; or iv. **Bank guarantee**. It shall be of a scheduled Bank in India in prescribed or other acceptable format or from other Issuer acceptable to the Procuring Entity. The bank guarantee shall be got verified from the issuing bank and confirmer, if any; or v. **Fixed Deposit Receipt (FDR)** of a Scheduled Bank in India. It shall be in the name of the Procuring Entity on account of Bidder and discharged by the Bidder in advance. The Procuring Entity shall ensure before accepting the Fixed Deposit Receipt that the Bidder furnishes an undertaking from the bank to make payment/ premature payment of the Fixed Deposit Receipt on demand

		to the Procuring Entity without requirement of consent of the Bidder concerned. In the event of forfeiture of the Performance Security, the Fixed Deposit shall be forfeited along with interest earned on such Fixed Deposit. vi. The Contractor shall have option to get the Performance Security deposited by deduction from his each running and final bill (Payment Certificate) @ 10% of the amount of the bill.
Additional Performance Security	**4.3.2**	i. If the Bid, which results in the lowest evaluated bid price, is seriously imbalanced or front loaded in the opinion of the Procuring Entity, the Procuring Entity 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, taking into consideration the schedule of estimated Contract payments, the Procuring Entity may require that the amount of the performance security be increased (to a maximum of 20% of the bid value of such items) at the expense of the Bidder to a level sufficient to protect the Procuring Entity against financial loss in the event of default by the successful Bidder under the Contract. ii. Without limitation to the provisions of the rest of this Sub-Clause, whenever the Engineer-in-charge determines an addition to the Contract Price as a result of a change in Cost, or as a result of a Variation of the Contract Price, the Contractor shall at the Engineer-in-charge's request promptly increase the Performance security to a level of 10 percent of the increased Contract Price.
	4.3.3	The proceeds of the Performance Security shall be forfeited and shall be payable as compensation to the Procuring Entity on happening of any of the events mentioned below: i. when the Contractor does not execute the agreement within the specified time; after issue of letter of acceptance/ placement of work order; or ii. when the Contractor fails to commence the work within the time specified; or iii. when the Contractor fails to complete the work satisfactorily within the time specified; or iv. when any terms and conditions of the contract is breached; or v. Failure by the Contractor to pay the Procuring Entity any amount due, either as agreed by the Contractor or determined under any of the Sub-Clauses of these Conditions or another agreement, within 30 Days of the service of notice to this effect by Engineer-in-Charge; or vi. if the Contractor breaches any provision of the Code of Integrity prescribed for Bidders specified in the Act, the Rules, ITB Sub-Clause 1.3 and Sub-Clause 4.2.1 of these conditions. Notice of reasonable time will be given in case of forfeiture of Performance Security. The decision of the Procuring Entity in this regard shall be final.
	4.3.4	The Contractor shall ensure that the Performance Security remains valid up to a period 60 days beyond fulfilment of all the obligations of the Contractor under the Contract, including defect liability and maintenance, if any. If the terms of the Performance Security specify its expiry date, and the Contractor has not become entitled to receive the Performance Certificate by the date 28 Days prior to the expiry date as provided in the Contract, the Contractor shall get extended the validity of the Performance Security. Failure by the Contractor to extend the validity of the Performance security as described herein above, in which event the Engineer-in-charge may claim the full amount of the performance security.
	4.3.5	The Procuring Entity shall return the Performance Security or release the Performance Security Declaration to the Contractor as below after completion of all obligations under the Contract, more specifically, after the expiry of the period as specified below: i. In case of contracts relating to hiring of trucks and other T&P, transportation

		including loading, unloading of materials, the Performance Security will be refundable along with the final bill. ii. Ordinary repairs: 3 months after the completion of the Works, provided the final bill has been paid. iii. Original Works / Special Repair Works: Performance Security will be refunded six months after completion, or after expiry of one full rainy season, or after expiry of defect liability period and maintenance period, if any specified in the Contract Data, whichever is later, provided the final bill has been paid. iv. In case of supply of materials: after 3 months of completion of supply, provided the final bill has been paid. v. In case of PWD original Works/ Special Repair Works costing more than Rupees 100 lakh, partial amount of Performance Security will be refunded during the defect liability @ 10% of the Performance Security amount after the lapse of one year of completion and thereafter 10% of original amount of Performance Security at the end of each subsequent year. The remaining amount of Performance Security will be refunded after the satisfactory expiry of the defect liability period.
	4.3.6	In the event of the Contract being determined or rescinded under any of the provisions of Sub-Clause 16.1, the Performance Security shall stand forfeited in full and shall be absolutely at the disposal of the Procuring Entity.
	4.3.7	For works for which a maintenance period of 3-5 years is also specified in addition to the defect liability period. The regular maintenance shall be a part of the BOQ of the Contract as a lump sum amount per annum to be paid on quarterly basis. Necessary price escalation as per provisions in the Contract shall also be payable for years subsequent to the expiry of the Defect Liability Period.
Commencement of Work at the earliest. Record the commencement or start date.	**4.4**	The Contractor shall commence the Works after signing of the Contract within the period as specified in the Special Conditions of the Contract. In case the Contractor does not commence the works within the above period, the Engineer-in-charge shall issue a notice after theexpiry of the said period. The actual date of commencement shall be duly recorded by the Engineer-in-Charge.
Contractor's Representative	**4.5**	Contractor shall appoint the Contractor's Representative and shall give him all authority necessary to act on the Contractor's behalf under the Contract. Unless the Contractor's Representative is named in the Contract, the Contractor shall, prior to the Commencement Date, submit to the Engineer-in-charge for consent the name and particulars of the person the Contractor proposes to appoint as Contractor's Representative. If consent is withheld or subsequently revoked in terms of this Sub-Clause, or if the appointed person ails to act as Contractor's Representative, or conducts improperly at the Site, the Contractor shall submit the name and particulars of another suitable person for such appointment. The former representative shall be removed within 24 hours of such notice by the Engineer-in-charge. The Contractor shall not, except if the representative has lost the confidence of the Contractor or is not complying to the instructions of the Engineer-in-charge or his assistants, remove without the prior consent of the Engineer-in-charge, revoke the appointment of the Contractor's Representative or appoint a replacement. The whole time of the Contractor's Representative shall be given to directing the Contractor's performance of the Contract. If the Contractor's Representative is to be temporarily absent from the Site during the execution of the Works, a suitable replacement person shall be appointed, subject to the Engineer-in-charge's prior consent, and the Engineer-in-charge shall be notified accordingly. The

		Contractor's Representative shall, on behalf of the Contractor, receive instructions under Sub-Clause 3.3 [Instructions of the Engineer-in-charge] and comply with them. The Contractor's Representative may delegate any powers, functions and authority to any competent person and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Engineer-in-charge has received prior notice signed by the Contractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked. The Contractor's Representative shall be fluent in the language for communications defined in Sub-Clause 1.4**.**If the Contractor's Representative's delegates are not fluent in the said language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Engineer-in-charge.
Sub-Contractor, nominated Sub-Contractor.	**4.6**	The Contractor shall not Sub-let or subcontract the whole/ or even part of the Works without the consent of the Engineer-in-charge. The Contractor shall submit a list of sub-contractors along with their credentials about (a) Technical capacity, (b) Financial capability and (c) the Experience of similar work, which is proposed to be sub-contracted**.** The Engineer-in-Charge (EIC) shall scrutinize the offers submitted by the Contractor, and shall approve the sub-contractors based on their overall capability to execute the proposed sub-contracted work. The agreement between the Contractor and each sub-contractor shall be submitted by the Contractor to the EIC and would require prior approval of the EIC. Such agreement between the Contractor and sub-contractor should be reasonable, workable and justified. If at any stage during execution, a sub-contractor is found working at Site without prior approval of the EIC, than the work being done by such Contractor shall be stopped at Site and payment to the Contractor for that particular work shall not be made by the EIC. It shall be responsibility of the Contractor to ensure that no unauthorized sub-contractor works on any work Site. If the Contractor does so, the Contract shall be liable to be terminated under Sub-Clause 16.1 [Termination by Procuring Entity]. Details of the capability of such proposed Sub-Contractors (except the nominated Sub-Contractor named by the Engineer-in-charge) shall be approved by the Engineer-in-charge. The Contractor shall be responsible for the misconduct, acts or defaults of any Sub contractor, his agents or employees, as if they were the acts or defaults of the Contractor. Unless otherwise stated: i the Contractor shall not be required to obtain consent to suppliers solely of materials, or to a subcontract for which the nominated Sub contractor is named in the Contract. ii the Contractor shall give the Engineer-in-charge not less than 28 Days' notice of the intended date of the commencement of each Sub-Contractor's work, and of the commencement of such work on the Site. The Contractor shall not be required to obtain such consent for: iii The provision of labours, iv The purchase of materials which are in accordance with the standards specified in the Contract, or
		The cost to be debited shall be arrived at as under: (a.) Cost of remedial work (including taxes) as paid to other agency or debited to

		v The subcontracting of any part of the works for which subcontractor is named in the Contract The Contractor shall ensure that the requirements imposed on the Contractor regarding Confidentiality as defined in the GCC Sub-Clause 1.16 [Confidential Details] shall apply equally to each nominated Subcontractor / Subcontractor.
Co-Operation	**4.7**	The Contractor shall, as specified in the Contractor as instructed by the Engineer-in-charge, allow appropriate opportunities for carrying out work to: i) the Procuring Entity's Personnel, ii) any other Contractors employed by the Procuring Entity, and iii) the personnel of any legally constituted public authorities, who may be employed in the execution on or near the Site of any work not included in the Contract. Any such instruction shall constitute a Variation if and to the extent that it causes the Contractor to suffer delays and/or to incur Unforeseeable Cost. Services for these personnel and other Contractors may include the use of Contractor's Equipment, Temporary Works or access arrangements which are the responsibility of the Contractor. If, under the Contract, the Procuring Entity is required to give to the Contractor, possession of any foundation, structure, plant or means of access in accordance with Contractor's Documents, the Contractor shall submit such documents to the Engineer-in-charge in the time and manner stated in the Specifications.
Safety Procedures at the site of works	**4.8.1**	The Contractor shall: i. prepare and submit for approval by the Engineer-in-charge an auditable safety plan at Site in accordance with relevant Code. The Contractor shall comply with all applicable safety regulations; ii. take care for the safety of all persons entitled to be on the Site; iii use reasonable efforts to keep the Site and Works clear of unnecessary obstruction so as to avoid danger to these persons; iv. provide fencing, lighting, guarding and watching of the works until completion and taking over under Sub-Clause 12.1 [Taking over of Works]; and v. provide any Temporary Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land. In addition to the provisions of this Contract, the Contractor shall follow the safety code of the Department.
Safety Provisions for labour	**4.8.2**	In respect of all labour directly or indirectly employed, noncompliance 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. Safely 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, the Engineer-in-Charge shall be entitled to provide for all such arrangements at the risk and cost of the Contractor plus 15% as agency charges.
Quality Assurance	**4.9.1**	The Procuring Entity shall have the right to exercise proper Quality Control measures to ensure that the works have been executed as per specifications and have the designed durability. It will be in three tiers: i. The first tier being the Contractor's engineers ensuring full compliance to specifications and conforming the same through testing (as per frequencies specified in the BIS, IRC or other relevant codes) on input materials, processes and the output in the field laboratory established by the Contractor at his cost . ii. The second tier shall be the Engineer-in-charge's team conducting such tests to the extent of the specified code frequency at the Contractor's field

		laboratory or Department/ Organization's laboratory and comparing the results with those carried out by the Contractor's Engineers; and iii. The third tier shall be the 'Third Party Quality Inspections' by the QCI approved / accredited Inspection Bodies as per ISO 17020, or by the Technical Examiner of the Department/ Organisation, where exists. The QCI approved / accredited Inspection Body may be selected through competitive bidding. The third tier shall conduct such tests to the extent of 10% of the specified frequencies duly witnessed by the Contractor's & Procuring Entity's Engineers and providing a final acceptability on the Works costing above Rs. 10 crores for buildings and structures and Rs.20 crores for roads, bridges/ flyovers, canals, dams, etc, as specified in the SCC. The Contractor shall provide all assistance to conduct such tests.
	4.9.2	The Contractor shall institute a approved quality assurance plan stating the methodology / responsibility for sampling, testing/ confirmatory testing, testing frequencies, statistical quality controls, observation / report formats, acceptance criteria, issue and resolution of Non Conformance Reports etc. to demonstrate compliance with the requirements of the specifications. The system shall be in accordance with the details stated in the Contract. The Engineer-in-charge shall be entitled to audit any aspect of the system. Details of all procedures and compliance documents shall be submitted to the Engineer-in-charge for information before each design and execution stage is commenced. When any document of a technical nature is issued to the Engineer-in-charge, evidence of the prior acceptance by the Contractor himself shall be apparent on the document itself. Compliance with the quality assurance system shall not relieve the Contractor of any of his duties, obligations or responsibilities under the Contract.
Site Data	**4.10.1**	The Procuring Entity shall have made available o the Contractor for his information, prior to the Base Date, all relevant data in the Procuring Entity's possession on sub-surface and hydrological conditions at the Site, including environmental aspects. The Procuring Entity shall similarly make available to the Contractor all such data which come in to the Procuring Entity's possession after the Base Date. The Contractor shall be responsible for verifying and interpreting all such data. The Procuring Entity shall not be held responsible about the correctness of all such data and the Contractor shall confirm/ verify all such data at his own cost.
	4.10.2	To the extent which was practicable (taking account of Cost and time), the Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Bid for Works. To the same extent, the Contractor shall be deemed to have inspected and examined the Site, its surroundings, the above data and other available information, and to have been satisfied before submitting the Bid as to all relevant matters, including (without limitation): i the form and nature of the Site, including sub-surface conditions, ii the hydrological and climatic conditions, iii the extent and nature of the work and goods necessary for the execution and completion of the Works and the remedying of any Defects, iv the Laws, procedures and labour practices of India, particularly Rajasthan, and v the Contractor's requirements for access, accommodation, facilities, personnel, power, transport, water and other services.
Sufficiency of the Contracted Amount	**4.11**	The Contractor shall be deemed to: i. have satisfied himself as to the correctness and sufficiency of the Accepted Contract Amount, and ii. have based the Accepted Contract Amount on the data, interpretations, necessary information, inspections, examinations and satisfaction as to all relevant matters referred to in Sub-Clause 4.10[Site Data].

		Unless otherwise stated in the Contract, the Accepted Contract Amount covers all the Contractor's obligations under the Contract (including those under Provisional Sums, if any) and all things necessary for the proper execution and completion of the Works and the remedying of any Defects.
Unforeseeable Physical Conditions	**4.12**	In this Sub-Clause, "physical conditions" means natural physical conditions and man-made and other physical obstructions and pollutants, which the Contractor encounters at the Site when executing the Works, including sub-surface and hydrological conditions but excluding climatic conditions. If the Contractor encounters adverse physical conditions which the Procuring Entity considers to have been Unforeseeable, the Contractor shall give notice to the Engineer-in-charge as soon as practicable. This notice shall describe the physical conditions, so that they can be inspected by the Engineer-in-charge, and shall set out the reasons why the Contractor considers them to be Unforeseeable. The Contractor shall continue executing the Works, using such proper and reasonable measures as are appropriate for the physical conditions, and shall comply with any instructions which the Engineer-in-charge may give. If an instruction constitutes a Variation, Clause 9 [Deviations, Variations and Adjustments] shall apply. If and to the extent that the Contractor encounters physical conditions which are Unforeseeable, gives such a notice, and suffers delay and/ or incurs Cost due to these conditions, the Contractor shall be entitled subject to notice under Sub-Clause 21.2 [Contractor's Claims] to: i. an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6[Extension of Time for Completion],and ii. payment of any such Cost, directed to be incurred by the Contractor as approved extra item which shall be included in the Contract Price. Upon receiving such notice and inspecting and/or investigating these physical conditions, the Engineer-in- charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine whether and (if so) to what extent these physical conditions were Unforeseeable, and the matters described in sub-paragraphs (i) and (ii) above related to this extent by the Contractor, but the Engineer-in-charge shall not be bound by the Contractor's interpretation of any such evidence. However, before additional Cost is finally agreed or determined under sub-paragraph (ii), the Engineer-in-charge may also review whether other physical conditions in similar parts of the Works (if any) were more favourable than could reasonably have been foreseen when the Contractor submitted the Bid. If and to the extent that these more favourable conditions were encountered, the Engineer-in-charge may proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the reductions in Cost which were due to these conditions, which may be included (as deductions) in the Contract Price and Payment Certificates. However, the net effect of all adjustments under sub-paragraph (ii) and all these reductions, for all the physical conditions encountered in similar parts of the Works, shall not result in a net reduction in the Contract Price.
Right of Way and Facilities	**4.13.1**	Unless otherwise specified in the Contract the Procuring Entity shall provide access to and possession of the Site including special and/or temporary rights-of-way which are necessary for the Works. The Contractor shall obtain, at his risk and Cost, any additional rights of way or facilities outside the Site which he may require for the purposes of the Works.
	4.13.2	The Contractor shall allow the Engineer-in-charge and any person authorized by the Engineer-in-charge access to the Site, to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where materials are being collected or stored or plant are being installed/ assembled for the Works. The contractor may satisfy himself regarding site, acquisition of land, approach roads etc.

Avoidance of Interference with public conveniences	**4.14**	The Contractor shall not interfere unnecessarily or improperly with: i. the convenience of the public, or ii. the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Procuring Entity or of others The Contractor shall indemnify and hold the Procuring Entity harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from any such unnecessary or improper interference.
Access Routes to Site	**4.15**	The Contractor shall be deemed to have been satisfied as to the suitability and availability of access routes to the Site at Base Date. The Contractor shall use reasonable efforts to prevent any road or bridge from being damaged by the Contractor's traffic or by the Contractor's Personnel. These efforts shall include the proper use of appropriate vehicles and routes. Except as otherwise stated in these Conditions: i the Contractor shall (as between the Parties) be responsible for any maintenance which may be required for his use of access routes; ii the Contractor shall provide all necessary signs or directions along access routes, and shall obtain any permission which may be required from the relevant authorities for his use of routes, signs and directions; iii the Procuring Entity shall not be responsible for any claims which may arise from the use or otherwise of any access route; iv the Procuring Entity does not guarantee the suitability or availability of particular access routes; and v Costs due to non-suitability or non-availability, for the use required by the Contractor, of access routes shall be borne by the Contractor.
Contractor's Equipment	**4.16**	The Contractor shall be responsible for all Contractor's Equipment. When brought on to the Site, Contractor's Equipment shall be deemed to be exclusively intended for the execution of the Works. The Contract or shall not remove from the Site any major items of Contractor's Equipment without the consent of the Engineer-in-Charge. However, consent shall not be required for vehicles transporting Goods or Contractor's Personnel offsite.
Protection of the Environment	**4.17**	The Contractor shall take all reasonable steps to protect the environment (both on and off the Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations. The Contractor shall ensure that emissions, surface discharges and effluent from the Contractor's activities shall not exceed the values stated in the Specifications or prescribed by applicable Laws. The Contractor shall, throughout the execution and completion of the Works and the remedying of any Defects therein: i. 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 the Procuring Entity) in an orderly state appropriate to the avoidance of danger to such persons; and ii. provide and maintain at his own Cost all lights, guards, fencing, warning signs and watchmen and other things necessary or required by the Engineer-in-charge or by any duly constituted authority, for the protection of the Works or for the safety and convenience of the public or others.
Electricity, Water and Gas	**4.18**	The Contractor shall, except as stated below, be responsible for the provision of all power, water and other services he may require for his construction activities and to the extent defined in the Specifications, for the tests. The Contractor shall be entitled to use for the purposes of the Works such supplies of electricity, suitable water, gas and other services as may be available on the Site with due permission of the service provider, on payment of billing value. The Contractor shall, at his risk and cost, provide any apparatus necessary for his use of these services and for measuring / paying for the quantities consumed.

		The quantities consumed and the amounts due for such services shall be agreed or determined by the Engineer- in- Charge in accordance with Sub-Clause 2.5 [Procuring Entity's Claims] and Sub-Clause 3.5 [Determinations]. The Contractor shall pay these amounts to the Procuring Entity /service provider.
Issue of Procuring Entity's Equipment and Materials ***(Not applicable in case of Lump Sum Contract)***	**4.19**	i The Procuring Entity may on request issue its machinery and equipment on hire to the Contractor, if available, for the use in the execution of the Works. The hire charges shall be as provided in the Contract Data or on the rates declared by the Procuring Entity in general. The Procuring Entity shall hand over the equipment in good working condition duly confirmed by the Contractor at the time of issue, along with departmental operators, helpers. The Contractor shall be responsible for the proper operation and care of the Procuring Entity's Equipment, POL, washout and ordinary repairs Contractor's operators shall not operate the equipment and the rentals / hire and other charges shall be deposited in advance for every 15 days by the Contractor failing which these shall be recovered from the immediately next Interim payment due to the Contractor. ii The Procuring Entity may issue materials like cement, steel, etc.(if available) to the Contractor for bonafide use in the Works at the rates specified in the Contract Data or at issue rate plus storage charges or free of cost, if it is a labour rate Contract, at the time and place specified in the Contract. *Such materials shall be issued at different stages in quantities calculated for each stage by the Engineer-in-Charge.*
Progress Reports	**4.20**	Unless otherwise stated in the Conditions, monthly progress reports shall be prepared by the Contractor and submitted to the Engineer-in-charge in specified number of copies along with the interim payment certificates, and the updated construction programme on MS Project or similar software for the next month. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 Days after the last day of the month to which it relates. Reporting shall continue until the Contractor has completed all works which is known to be out standing at the completion date stated in the Taking-Over Certificate for the Works. Each report shall include: i charts, drawings, outputs and detailed descriptions of progress, including each stage of design (if any) on MS project or similar software, Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection and testing; and including these stages for work by each nominated Subcontractor(as defined in Sub-Clause 5.2 [Nomination of Sub-Contractors]; ii photographs (in adequate numbers) showing the status of progress of works on the Site; iii the details described in Sub-Clause 6.12 [Records of Contractor's Personnel & Equipment]; iv copies of quality assurance documents, test results, test certificates of manufactured Materials and action taken on Third Party Quality Inspections by the Contractor; v list of notices given under Sub-Clause 2.5 [Procuring Entity's Claims] and notices given under Sub-Clause 21.2 [Contractor's Claims]; vi safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and vii comparisons of actual and planned progress, hindrances, with details of any events or circumstances which may jeopardize the completion in accordance with the Contract, and the measures being (or to be) adopted to overcome delays.
Security of the Site and Works	**4.21**	Unless otherwise stated in the Conditions: i the Contractor shall be responsible for keeping unauthorized persons off the Site, ii authorized persons shall be limited to the Contractor's Personnel and the

		Procuring Entity's Personnel; and to any other personnel notified to the Contractor by the Procuring Entity or the Engineer-in-charge, as authorized personnel of the Procuring Entity's other Contractors on the Site. iii The contractor shall arrange to protect, at his own cost, in an adequate manner, all cut stone work and other work, requiring protection and to maintain such protection as long as work is in progress. He shall remove and replace this protection, as required by the Engineer-in-charge, from time to time. Any damage to the work, so protected, no matter how it may be caused, shall be made good by the Contractor free of cost. All templates, forms. moulds, centering, false works and models which in the opinion of the Engineer-in-charge are necessary for the proper and workman like execution of the work, shall be provided by the Contractor free of cost. iv The Contractor shall arrange to keep the site and works secure from manmade disasters, explosions by design or by accident or both at his own cost.
Contractor's Operations on Site	**4.22**	The Contractor shall confine his operations to the Site, and to any additional areas which may be obtained by the Contractor and agreed to by the Engineer-in-charge as additional working areas. The Contractor shall take all necessary precautions to keep Contractor's Equipment and Contractor's Personnel within the Site and these additional areas, and to keep them off adjacent land. During the execution of the Works, the Contractor shall keep the Site free from all unnecessary obstruction, and shall store or dispose of any Contractor's Equipment or surplus Materials. The Contractor shall clear away and remove from the Site any wreckage, rubbish and Temporary Works which are no longer required. When the annual repairs and maintenance of Works are carried out, the splashes and droppings from white washing, colour 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 Sub-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. Upon the issue of a Taking-Over Certificate, the Contractor shall clear away and remove, from that part of the Site and Works to which the Taking-Over Certificate refers, all Contractor's Equipment, surplus material, wreckage, rubbish and Temporary Works. The Contractor shall leave that part of the Site and the Works in a clean and safe condition. However, the Contractor may retain on Site, during the Defects Notification Period, such goods, equipment as are required by the Contractor to fulfil obligations under the Contract.
Fossils / antiques and articles of value	**4.23**	All fossils, coins, articles of value or antiquity, and structures and other remains or items of geological or archaeological interest found on the Site shall be placed under the care and authority of the Engineer-in-charge / Procuring Entity. The Contractor shall take reasonable precautions to prevent Contractor's Personnel or other persons from removing or damaging any of these findings. The Contractor shall, upon discovery of any such finding, promptly give notice to the Engineer-in-charge, who shall issue instructions for dealing with it. If the Contractor suffers delay and/or incurs Cost from complying with the instructions, the Contractor shall give a further notice to the Engineer-in- charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i. an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion]; and ii. Payment of any such Cost, which shall be included in the Contract Price. After receiving this further notice, the Engineer-in- charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.

Completion Plans to be Submitted by the Contractor	**4.24**	The Contractor shall submit completion drawings, designs within thirty Days of the virtual completion of the Works. In case, the Contractor fails to submit the completion drawings, designs as aforesaid, the Engineer-in-charge shall be authorised to get these as built drawings, designs and other data prepared in 6 copies (4 hard and two soft) at the cost of the Contractor.
Contractor to Supply Tools & Plants etc.	**4.25**	The Contractor shall provide at his own Cost all materials plant, tools, appliances, implements, ladders, cordage, tackle, scaffolding and Temporary Works required for the proper execution of the Works, whether original, altered or substituted and whether included or not in the Specification or other documents forming part of the Contractor referred to in these conditions, 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 Works. The Contractor shall also supply without charge the requisite number of persons with the means and materials, necessary for the purpose of setting out Works, and counting, weighing and assisting the measurement for examination at any time and from time to time of the work or Materials. Failing his so doing the same may be provided by the Engineer-in-Charge at the actual Cost +15% as agency charges to the Contractor, under this Contract or otherwise and/ or from his Performance Security or the proceeds of sale thereof, or of a sufficient portion thereof.
Changes in the firm's constitution to be intimated	**4.26**	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 subcontracted in contravention of Sub-Clause 4.6 [Sub-Contractor, nominated Sub-Contractor] and the same action may be taken and the same consequences shall ensue as provided in the Sub-Clause 16.1 [Termination by Procuring Entity]
5. Sub-Contractor and Nomination of Sub-Contractor		
Sub-Contractor	**5.1**	A Sub Contractor, if permitted under the Contract, is a firm or a person specified by the Contractor in his Bid along with details of his capabilities on equipment/ machineries, personnel (technical and others), experience on similar works specific to the project, commitment to Quality assurance etc. He should not have been debarred by the Procuring Entity or the State Government.
Nomination of Sub-Contractor	**5.2**	In the Contract, "nominated Sub-Contractor" means a Sub-Contractor: (a) who is stated in the Contract as being a nominated Sub-contractor, or (b) Whom the Engineer-in-charge, instructs the Contractor to employ as a Sub contractor subject to Sub-Clause 5.3 [Objection to Nomination].
Objections to nominations	**5.3**	The Contract or shall not be under any obligation to employ a nominated Sub-contract or against whom the Contract or raises reasonable objection by notice to the Engineer-in-charge as soon as practicable, with supporting particulars.
Payment to Nominated Sub-Contractor	**5.4**	The Contractor shall pay to the Nominated Sub-Contractors the amounts shown on the Nominated Sub-contractor's invoices approved by the Contractor which the Engineer-in-charge certifies to be due in accordance with the sub-contract. These amounts plus other charges paid to the Nominated Sub-Contractor shall be included in the Contract Price in accordance with Sub-Clause9.6 [Provisional Sums].
Evidence of payments	**5.5**	Before issuing a Payment Certificate which includes an amount payable to a nominated Subcontractor, the Engineer-in-Charge may request the Contractor to supply reasonable evidence that the nominated Subcontractor has received all amounts due in accordance with previous Payment Certificates, less applicable deductions for retention or otherwise. Unless the Contractor: (a) submits this reasonable evidence to the Engineer-in-Charge, or

		(b) (i) satisfies the Engineer-in-Charge in writing that the Contractor is reasonably entitled to withhold or refuse to pay these amounts, and (ii) submits to the Engineer-in-Charge reasonable evidence that the nominated Subcontractor has been notified of the Contractor's entitlement, then the Procuring Entity may (at his sole discretion) pay, direct to the nominated Subcontractor, part or all of such amounts previously certified (less applicable deductions) as are due to the nominated Subcontractor and for which the Contractor has failed to submit the evidence described in sub-paragraphs (a) or (b) above. The Contractor shall then repay, to the Procuring Entity, the amount which the nominated Subcontractor was directly paid by the Procuring Entity.
6. Engagement of Staff and Labour by the Contractor		
Staff and Labour	**6.1**	i. Except as otherwise stated in the Specifications, the Contractor shall make arrangements for the engagement of all staff and labour, local or otherwise, and for their payment, water, power, healthcare backup, transport and, when appropriate, housing. ii. The Contractor is encouraged, to the extent practicable and reasonable, to employ staff and labour with appropriate qualifications and experience from sources within India. iii. No Engineer of gazetted rank or other gazetted officer employed in Engineering or administrative duties in an Engineering Department of the Government of Rajasthan 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. The 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.
Bidder barred from bidding if near Relatives working in Procuring Entity's office	**6.2**	The Contractor shall not be permitted to bid for works of a Procuring Entity in which his near relative is an employee. He shall also not have a person as his employee who is a near relative of an employee of the Procuring Entity. Any breach of this condition by the Contractor shall be considered as breach of Code of Integrity and shall render him liable to action under Section 11(3) of the Act which includes exclusion of his Bid from procurement process, forfeiture of Bid Security, Performance Security or any other security or bond relating to procurement, recovery of payments made, if any, along with interest at bank rate, cancellation of the Contract, if already made, debarment from future bidding for a period up to three years, etc. ***Note:*** *By the term 'near relative' is meant wife, husband, parents and grand- parents, children and grand- children, brothers and sisters, uncles and cousins and their corresponding in- laws.*
Employment of Technical Staff and other Employees	**6.3.1**	The Contractor shall Engage technical personnel as per list provided for in the Contract and provide all necessary superintendence during execution of the Works and as long thereafter as may be necessary for proper fulfilling of the obligations under the Contract. The EIC of the Contractor shall be his principal technical representative. Other personnel shall be engaged as specified in the qualification criteria.
	6.3.2	The technical staff should always be available at site whenever required by Engineer- in- charge to take instructions. The Contractor shall comply with the provisions of the Apprenticeship Act, 1961, and the Rules and Orders issued, there under, from time to time. If he fails to do so, his failure will be a breach of 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.
		the contractor if the remedial action is taken up by the department/ organisation, plus (b.) A compensation of 15% , less

Responsibility of the Technical Staff and employees	**6.4**	Technical officers/ staff deployed by the Contractor at any construction Site will be responsible for proper quality of Works and physical targeted progress of the Works.
Rate of Wages and Conditions of Labour	**6.5**	The Contractor shall not pay less than fair wages/ minimum wages to labourers engaged by him on the Works as revised from time to time by the State Government, but the Procuring Entity shall not be liable to pay anything extra for it except as stipulated in price escalation Sub-Clause of the agreement. **Explanation:** "Fair Wage" means minimum wages for time or piece work, fixed or revised, by the State Government under the Minimum Wages Act, 1948. The Contractor shall, notwithstanding the provisions of any contract to the contrary, cause to be paid fair wages to labourers directly or indirectly engaged on the Works, including any labour engaged by his Sub-Contractors in connection with the said Works as if the labourers have been immediately or directly employed by him. In respect of all labourers, immediately or directly employed on the Works, for the purpose of Contractor's part of this agreement, the Contractor shall comply with or cause to be complied with the Public Works Department Contractor's Labour Regulations made, or that maybe made by the State Government from time to time in Regard to payment of wages, wage period, deductions from wages, recovery of wages not paid, and unauthorized deductions, maintenance of wages register, wage card, publication of scale of wages and other terms of employment, inspection and submission of periodical returns and other matters of a like nature. The Engineer-in-charge shall have the right to deduct from the money due to the Contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers, by reasons of non-fulfilment of the conditions of the Contract, for the benefit of the worker or the workers, non-payment of wages or of deductions made there from, which are not justified by the terms of the Contract, or as a result of non-observance of the aforesaid regulations. Vis-à-vis the State Government of Rajasthan, the Contractor shall be primarily liable for all payments to be made and for the observance of the regulations aforesaid, without prejudice to his right to claim indemnity from his Sub-Contractors. The regulations, aforesaid, shall be deemed to be part of this Contract and any breach, thereof, shall be deemed to be breach of the Contract.
Contractor not to engage staff of Procuring Entity	**6.6**	The Contractor shall not recruit, or attempt to recruit, full time (on leave) or part time the staff and labour from amongst the Procuring Entity's Personnel in any capacity.
Working Hours	**6.7**	No work shall be carried out on the Site on locally recognized Days of rest, or outside the normal working hours stated in the Contract Data, unless: i otherwise stated in the Contract, ii. the Engineer-in-charge gives consent, or iii the work is unavoidable, or necessary for the protection of life or property or for the safety of the Works, in which case the Contractor shall immediately advise the Engineer-in-charge.
Facilities for Staff and Labour	**6.8**	Except as otherwise stated in the Specifications, the Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel. The Contractor shall also provide work site facilities for the Procuring Entity's Personnel as stated in the Specifications. The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the structures forming part of the Permanent Works.
Health & Safety	**6.9**	The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities, the Contractor shall ensure that medical staff, first aid facilities, sick bay, doctor at call and ambulance service are available at all times at the Site

		and at any accommodation for Contractor's and Procuring Entity's Personnel, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The Contractor shall appoint a safety officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified and trained for this responsibility, and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the execution of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority. The Contractor shall send, to the Engineer-in-charge, details of any accident occurred at the Site or to or due to the Works, as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Engineer-in-charge may reasonably require.
Contractor's Superintendence	**6.10**	Throughout the execution of the Works, and as long thereafter as is necessary to fulfil the Contractor's obligations, the Contractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect and test the Works. Superintendence shall be given by a sufficient number of persons having adequate knowledge of the language for communications (defined in Sub-Clause 1.4 [Law and Language] and of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Works.
Contractor's Personnel	**6.11**	Contractor's Personnel shall be appropriately qualified, skilled and experienced in respective trades or occupations. The Engineer- in-charge may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's Representative, if applicable, who: i. persists in any misconduct or lack of care, ii carries out duties incompetently or negligently, iii. fails to conform with any provisions of the Contract, or iv. Persists in any conduct which is prejudicial to safety, health, or the protection of the environment. If appropriate, the Contractor shall then appoint (or cause to be appointed) a suitable replacement person.
Records of Contractor's personnel and Equipment	**6.12**	The Contractor shall provide all required equipment, machinery at the Site and submit to the Engineer-in-charge, details showing the number of each category of Contractor's Personnel and of each type of Contractor's Equipment on the Site. Details shall be submitted each calendar month, in a form approved by the Engineer-in-charge, until the Contractor has completed all work which is known to be outstanding at the completion date stated in the Taking-Over Certificate for the Works.
Disorderly Conduct	**6.13**	The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst the Contractor's Personnel, and to preserve peace and protection of persons and property on and near the Site.
Foreign Personnel	**6.14**	Is permitted, the Contractor may bring in to the Country any foreign personnel who are necessary for the execution of the Works to the extent allowed by the applicable Laws. The Contractor shall ensure that these personnel are provided with the required residence visas and work permits. The Procuring Entity will, if requested by the Contractor, use his best endeavours in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national, or Government permission required for bringing in the Contractor's personnel. The Contractor shall be responsible for the return of these personnel to the place where they were recruited or to their domicile. In the event of the death in the Country of any of these personnel or members of their families, the Contractor shall similarly be responsible for making the appropriate arrangements for their

		return or burial.
Supply of Food Stuffs	**6.15**	The Contractor shall arrange for the provision of a sufficient supply of suitable food stuff as may be stated in the Specification at reasonable prices for the Contractor's Personnel for the purposes of or in connection with the Contract.
Supply of Water and Electricity	**6.16**	The Contractor shall, provide at his cost an adequate supply of potable drinking water, as well as water for use in construction and for use of the Contractor's Personnel, at site. The Contractor shall, provide at his cost an adequate supply of electricity for use in construction and for use of the Contractor's Personnel, at site.
Measures against Insect and Pest Nuisance	**6.17**	The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce their danger to health. The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.
Alcoholic Liquor or Drugs	**6.18**	The Contractor shall not, otherwise than in accordance with the Laws of the Country, import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift, barter or disposal there to by Contractor's Personnel. He shall also not allow the consumption of such Alcoholic Liquor/Drugs at Site during working hours.
Arms and Ammunition	**6.19**	The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms or ammunition of any kind, or allow Contractor's Personnel to do so.
No unlicensed storage of Explosives and POL	**6.20**	The Contractor is not authorised to store explosives and POL or other inflammable materials without a valid license from the competent legal authority.
Prohibition of Forced or Compulsory labour	**6.21**	The Contractor shall not employ forced or compulsory labour, which consists of any work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty, and includes any kind of involuntary or compulsory labour, such as indentured labour, bonded labour or similar labour-contracting arrangements.
Prohibition of Child Labour	**6.22**	The Contractor shall comply with the provisions of Acts and rules pertaining to prohibition of employment of child labour including not employing any child to perform any work that is economically exploitative, or is likely to be hazardous to, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development.
Festivals and Religious Customs	**6.23**	The Contract or shall respect the Country's recognized festivals, days of rest and religious or other customs.
Employment Records of Workers	**6.24**	The Contractor shall keep complete and accurate records of the employment of labour at the Site. The records shall include the names, ages, genders, hours worked and wages paid to all workers. These records shall be summarized on a monthly basis and submitted to the Engineer-in-charge, and these records shall be available for inspection by Auditors / labour inspectors and others as per law during normal working hours. These records shall be included in the details to be submitted by the Contractor under Sub-Clause 6.12 [Records of Contractor's Personnel and Equipment].
Compliance with Labour Laws	**6.25**	The Contractor shall comply with all the relevant labour Laws applicable to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights. The Contractor shall require his employees to obey all applicable Laws, including those concerning safety at work. The Contractor shall obtain a valid license under the State Labour Act, and the

		Contract Labour (Regulation and Abolition) Central Rules 1961, before the commencement of the Works, and continue to have a valid license until the completion of the Works. 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.
Payment of Wages	**6.26**	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, where applicable. ii The Contractor shall, notwithstanding the provisions of any Contract to the contrary, cause to be paid for wages to labour indirectly engaged on the Works including any labour engaged by his sub-Contractors in connection with the said Works, as if the labour had been immediately employed by him.
Penalty for non-compliance with labour Laws	**6.27**	i In respect of all labour directly or indirectly employed in the Works of 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 the Government from time to time in regard to payment of wages, wage period, deductions from wages, recovery of wages not paid and any unauthorised deductions 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 as per the Provisions of Contract Labour (Regulation & Abolition) Act, 1970, and the Contract Labour (Regulation & Abolition) Central Rules,1971, wherever applicable. ii The Engineer-in-Charge concerned shall have the right to deduct from the moneys due to the Contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers by reason of non-fulfilment of the conditions of the Contract for the benefit of the workers, non-payment of wages or of deductions, made from his or their wages which are not justified by their terms of the Contract or non-observance of the Regulations. iii Under the provision of Minimum Wages (Central) Rules 1950, the Contractor is bound to allow to the labour 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 labour and pay the same to the persons entitled thereto from any money due to the Contractor by the Engineer-in-Charge concerned. iv 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 relevant Labour Laws and the rules made there under from time to time. v The Contractor shall indemnify and keep indemnified the State Government/ Procuring Entity 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. vi 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. vii Whatever is the minimum wage for the time being, or if the wage payable higher than the minimum wage, such wage shall be paid by the Contractor

		to the workmen directly without the intervention of Jamadar and that Jamadar shall not be entitled to deduct or recover any amount from the minimum wage payable to the workmen as and by way of commission or otherwise. The Contractor shall ensure that no amount by way of commission or otherwise is deducted or recovered by the Jamadar from the wage of workmen.
7. Execution of works and workmanship		
Manner of Execution	**7.1**	• The Contractor shall procure and transport all materials in an expeditious and orderly manner to the Site and shall at its own risk and expense transport all the materials and the Contractor's Equipment to the Site by the mode of transport that the Contractor judges most suitable under all the circumstances. • Unless otherwise provided in the Contract, the Contractor shall be entitled to select any safe mode of transport operated by any person to carry the materials and the Contractor's Equipment. • Upon dispatch of each shipment of materials and the Contractor's Equipment, the Contractor shall notify the Employer by telex, cable, facsimile, or electronic means, of the description of the materials and of the Contractor's Equipment, the point and means of dispatch, and the estimated time and point of arrival in the country where the Site is located, if applicable, and at the Site. The Contractor shall furnish the Employer with relevant shipping documents to be agreed upon between the parties. • The Contractor shall be responsible for obtaining, if necessary, approvals from the authorities for transportation of the materials and the Contractor's Equipment to the Site. The Employer shall use its best endeavors in a timely and expeditious manner to assist the Contractor in obtaining such approvals, if requested by the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any claim for damage to roads, bridges, or any other traffic facilities that may be caused by the transport of the materials and the Contractor's Equipment to the Site. • The Contractor shall, at its own expense, handle all imported materials and Contractor's Equipment at the point(s) of import and shall handle any formalities for customs clearance, subject to the Employer's obligations under GCC, provided that if applicable laws or regulations require any application or act to be made by or in the name of the Employer, the Employer shall take all necessary steps to comply with such laws or regulations. In the event of delays in customs clearance that are not the fault of the Contractor, the Contractor shall be entitled to an extension in the Time for Completion, pursuant to GCC Clause 40. • The Contractor will carry out works, production of mixes, the procurement of input materials, and all other execution of the Works.: 1. in the manner (if any) specified in the Contract, 2. in a proper workman like and careful manner, in accordance with recognized good practices, and 3. with properly equipped facilities and non-hazardous materials, except as otherwise specified in the Contract.
Samples	**7.2**	The Contractor shall submit the following samples of Materials, and relevant information, to the Engineer-in-charge for consent prior to using the Materials in or for the Works: i Contractor's standard samples of raw/ produced Materials and samples specified in the Contract, all at the Contractor's Cost, and ii additional samples instructed by the Engineer-in-Charge as a Variation. Each sample shall be labelled as to origin and intended use in the Works. Samples shall also be collected by the Quality testing/inspection teams from the works in progress and the Contractor shall willingly cooperate with such quality assurance procedures.

Inspection	**7.3**	7.3.1 The Procuring Entity's Personnel shall at all reasonable times: i have full access to all parts of the Site and to all places from which natural materials are being obtained, and ii during production, manufacture and construction (at the Site and elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship, and to check the progress of manufacture of Plant and production and manufacture of materials. The Contractor shall give the Procuring Entity's Personnel full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Contractor from any obligation or responsibility. 7.3.2 The Contractor shall give notice of minimum 07 days to the Engineer-in-charge whenever any work is ready and before it is covered up, put out of sight, or packaged for storage or transport, beyond measurement, any work in order that the same may be measured and correct dimensions thereof, be taken before the same is covered up. The Engineer-in-charge shall then either carry out the examination, inspection, measurement or testing without unreasonable delay, or promptly give notice to the Contractor that the Engineer-in-charge does not require to do so. If the Contractor fails to give the notice, he shall, if and when required by the Engineer-in-charge, uncover the work and thereafter reinstate and make good, all at the Contractor's Cost. 7.3.2 The Engineer-In-Charge may require the Contractor to carry out any test and/or inspection not required by the Contract, provided that the Contractor's reasonable costs and expenses incurred in the carrying out of such test and/or inspection shall be added to the Contract Price. Further, if such test and/or inspection impedes the progress of work on the Facilities and/or the Contractor's performance of its other obligations under the Contract, due allowance will be made in respect of the Time for Completion and the other obligations so affected. 7.3.4 The Contractor shall provide the Engineer-In-Charge (EIC) with a certified report of the results of any such test and/or inspection. If the Employer or EIC or their designated representatives fails to attend the test and/or inspection, or if it is agreed between the parties that such persons shall not do so, then the Contractor may proceed with the test and/or inspection in the absence of such persons, and may provide the EIC with a certified report of the results thereof. 7.3.5 If any Plant or any part of the Facilities fails to pass any test and/or inspection, the Contractor shall either rectify or replace such Plant or part of the Facilities and shall repeat the test and/or inspection upon giving a notice under GCC Subclause 7.3.1 7.3.6 The Contractor agrees that neither the execution of a test and/or inspection of Plant or any part of the Facilities, nor the attendance by the Employer or the EIC, nor the issue of any test certificate pursuant to GCC Subclause 7.3.4, shall release the Contractor from any other responsibilities under the Contract. 7.3.7 No part of the Facilities or foundations shall be covered up on the Site without the Contractor carrying out any test and/or inspection required under the Contract. The Contractor shall give a reasonable notice to the EIC whenever any such parts of the Facilities or foundations are ready or about to be ready for test and/or inspection; such test and/or inspection and notice thereof shall be subject to the requirements of the Contract. The Contractor shall uncover any part of the

		Facilities or foundations, or shall make openings in or through the same as the EIC may from time to time require at the Site, and shall reinstate and make good such part or parts.
Stores supplied by the Procuring Entity ***(Not applicable in case of Lump Sum Contract)***	**7.4**	If the specification or estimate of the Works provide for the use of any special description of materials, to be supplied from the Engineer In charge's stores, or if, it is required that Contractor shall use certain stores to be provided by the Engineer In charge specified in the Schedule or Memorandum hereto annexed, the Contractor shall be bound to procure and shall be supplied such materials and stores as are, from time to time, required to be used by him for the purpose of the Contract only, and the value of the full quantity of materials and stores, so supplied, at the rates specified in the said Schedule or Memorandum, may be set off or which may be deducted from any sum, then due or thereafter become due, to the Contractor under the Contract or otherwise or against or from the Performance Security or the proceeds of sale, if the same is held in Government securities, the same or a sufficient portion thereof being in this case, sold for this purpose. All materials supplied to the Contractor, either from departmental stores or with the assistance of the Procuring Entity, shall remain the absolute property of the Procuring Entity. The Contractor shall be the trustee of the stores/ materials, so supplied/ procured and these shall not, on any account, be removed from the Site of the Works and shall be, all times, open to inspection by the Engineer In charge. Any such materials, unused and in perfectly good condition at the time of completion or determination or rescinding of the Contract, shall be returned to the Engineer In charge's Stores, if, by a notice in writing under his hand, he shall so require, and if on service of such notice, the Contractor fails to return the materials, so required, he shall be liable to pay the price of such materials. But the Contractor shall not be entitled to return any such materials, unless with such consent, and shall have no claim for compensation on account of any such materials, so supplied to him as aforesaid being unused by him, or for any wastage in or damage to any such materials. For the stores returned by the Contractor, he shall be paid for, at the price originally charged excluding storage charges, in case of materials supplied from departmental stores and actual cost including freight, cartage, taxes etc., paid by the Contractor, in case of supplies received with the assistance of the Procuring Entity, however, should in no case exceed market rate prevailing at the time the materials are taken back. The decision of the Engineer In charge, as to the price of the stores returned, keeping in view its condition etc., shall be final and conclusive. In the event of breach of the aforesaid condition, the Contractor shall, in addition to throwing himself open to account for contravention of the terms of the license or permit and/or for criminal breach of trust, pay to the Procuring Entity, all advantages or profits resulting or which in the usual course, would result to him by reason of such breach. Provided that the Contractor shall, in no case be entitled to any compensation or damage on account of any delay in supply, or non-supply thereof, all or any such materials and stores.
Penalty rate in case of excess consumption ***(Not applicable in case of Lump Sum Contract)***	**7.5**	The Contractor shall return the materials issued free of cost to him and found surplus after its intended consumption in the Works, immediately. The Contractor shall be charged for the materials which were not returned or consumed in excess of the requirements calculated on the basis of standard consumption approved by the Procuring Entity, at double of the issue rate including storage and supervision charges or market rate, whichever is higher. A Materials Supply and Consumption Statement, in prescribed Form RPWA 35A, shall be submitted with every Payment Certificate, distinguishing materials supplied by the Procuring Entity and materials procured by the Contractor himself. The recovery for such materials shall be made from Payment Certificate next after the consumption and shall not be deferred. Certificate of such nature shall be given in each Payment Certificate.

Hire of Plant and Machinery	**7.6**	Plant and Machinery, required for execution of the Works, may be issued to the Contractor, if available, on the rates of hire charges and other terms and conditions as per the departmental/ Organisation Rules, as per Schedule annexed to these conditions. Rates of such Plant & Machinery shall be got revised periodically so as to bring them at par with market rate.
Imported Store articles to be obtained from the Procuring Entity ***(Not applicable in case of Lump Sum Contract)***	**7.7**	The Contractor shall obtain from the stores of the Engineer-in-charge, all imported store articles, which may be required for the Works or any part thereof, or in making up articles required thereof, or in connection therewith, unless he has obtained permission, in writing, from the Engineer In charge. To obtain such stores and articles from elsewhere. The value of such stores and articles, as may be supplied to the Contractor by the Engineer In charge, will be debited to the Contractor, in his account, at the rates shown in the Schedule attached to the Contract, and if they are not entered in the Schedule, they will be debited at cost price, which for the purposes of this Contract, shall include the cost of carriage and all other expenses, whatsoever, which shall have been incurred in obtaining delivery of the same at the stores aforesaid plus storage charges.
Materials Supplied by the Contractor	**7.8**	The Contractor shall, at his own expense, provide all materials conforming to the specifications from the sources approved by the Engineer-In-Charge, required for the Works other than those, which are stipulated, to be supplied by the Procuring Entity. Samples for all such materials shall be collected by the Contractor and tested in the presence of representative of the Engineer-in-Charge, at the field laboratory established by the Contractor at the site. Tests which cannot be carried out at the field laboratory, shall be got tested at an NABL accredited laboratory, or any ISI approved laboratory or a Government /Departmental laboratory approved by the Engineer-in-Charge. Only materials so approved shall be used in the works and any change of materials shall be similarly got approved again. Works constructed/executed with unapproved materials shall be summarily rejected without any further investigation or testing. 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 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 from other suitable sources and all Costs which may be incurred for such removal and substitution shall be borne by the Contractor.
Testing	**7.9.1**	This Sub-Clause shall apply to all tests specified in the Contract, other than the Tests after Completion (if any). Except as otherwise specified in the Contract, the Contractor shall provide a field laboratory with all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Contractor shall agree, with the Engineer-in- charge, the time and place for the specified testing of any Plant, Materials and other parts of the Works. The Engineer-in-charge may, under Sub-Clause 9.2.1 [Deviations/ Variations, Extent and Pricing], vary the location or details of specified tests, or instruct the Contractor to carry out additional tests. If these varied or additional tests show that the tested Plant, Materials or works or workmanship is not in accordance with the Contract, the Cost of carrying out this variation shall be borne by the

		Contractor, notwithstanding other provisions of the Contract. The Engineer-in-charge shall give the Contractor not less than 24 hours' notice of the Engineer-in-charge's intention to attend the tests. If the Engineer-in-charge does not attend at the time and place agreed, he may designate a qualified and authorised person to attend the testing, if not, the Contractor may approach the Procuring Entity for deputing an Engineer / any other experienced person to witness the tests. In no case shall the tests be conducted without an Engineer/competent person representing the Procuring Entity.
	7.9.2	If the Contractor suffers delay and/or incurs Cost from complying with these instructions or as a result of a delay for which the Procuring Entity is responsible, the Contractor shall give notice to the Engineer-in-charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion], and ii payment of any such Cost, which shall be included in the Contract Price. After receiving this notice, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters The Contractor shall promptly forward to the Engineer-in- charge, duly certified reports of the tests. When the specified tests have been passed, the Engineer-in-charge shall endorse the Contractor's test certificate.
Cost of Samples	**7.10**	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.
Cost of Tests	**7.11**	The Cost of conducting any test shall be borne by the Contractor if such test is: i. clearly intended by or provided for in the Contract, or ii. particularised 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 for which it was intended to fulfil) in sufficient detail to enable the Contractor to price or allow for the same in his Bid.
Cost of Tests not provided for	**7.12**	If any test required by the Engineer-in-charge which is: i not so intended by or provided for in the Contract or codes; ii (in the cases above mentioned) not so particularized, or iii (though so intended or provided for), if required by the Engineer-in-charge to be carried out at any place other than the Site or the place of manufacture, fabrication or preparation of the Materials or Plant, on test shows the Materials, Plant or work or workmanship not to be in accordance with the provisions of the Contract/ specifications to the satisfaction of the Engineer-in-charge, then the Cost of such test shall be borne by the Contractor, but in any other case Department/ Organisation will bear the Cost.
Rejection	**7.13**	If, as a result of an examination, inspection, measurement or testing, any Plant, Materials, works or workmanship is found to be defective or otherwise not in accordance with the Contract, the Engineer-in-charge may reject the works, Plant, Materials or workmanship by giving notice to the Contractor, with reasons. The Contractor shall then promptly make good the defect and ensure that the reconstructed/ reproduced/ replaced item complies with the Contract. If the Engineer-in-charge requires this Plant, Materials, works, or workmanship to be retested, the tests shall be repeated under the same terms and conditions. If the rejection and retesting cause the Procuring Entity to incur additional Costs, the Contractor shall subject to Sub-Clause 2.5 [Procuring Entity's Claims] pay these Costs to the Procuring Entity.
Remedial Work	**7.14**	Notwithstanding any previous test or certification, the Engineer-in-charge may instruct the Contractor to: i. remove from the Site and replace any works, Plant or Materials which is not in accordance with the Contract, ii. remove and re-execute any other work which is not in accordance with the Contract, and

		iii. execute any work which is urgently required for the safety of the Works, whether because of an accident, unforeseeable event or otherwise. The Contractor shall comply with the instruction within a reasonable time, which shall be the time (if any)specified in the instruction, or immediately if urgency is specified under sub-paragraph iii. If the Contractor fails to comply with the instruction, the Procuring Entity shall be entitled to employ and pay other persons to carry out the work. Except to the extent that the Contractor would have been entitled to payment for the work, the Contractor shall subject to Sub-Clause 2.5 [Procuring Entity's Claims] pay to the Procuring Entity all Costs arising from this failure.
Ownership of Plant and Materials	**7.15**	Except as otherwise provided in the Contract, each item of Plant and Materials shall, to the extent consistent with the Contract, become the property of the Procuring Entity at whichever is the earlier of the following times, free from liens and other encumbrances: i when it is incorporated in the Works; ii when the Contractor is paid the corresponding value of the Plant and Materials under Sub-Clause 8.12 [Payment for Plant and Materials in event of Suspension].
Dismantled Material Government Property	**7.16**	The Contractor, in course of the Works, should understand that all materials e.g. stone, bricks, steel and other materials obtainable in the Works by dismantling etc. will be considered as the property of the Procuring Entity and will be disposed off to the best advantage of the Procuring Entity, as per directions, of the Engineer-in-charge.
Action where no Specifications are provided.	**7.17**	In the case of any class of works for which there are no specifications in Bureau of Indian Standards Specifications, Indian Road Congress for road Works and Indian Building Congress for building Works or any Central Government agency, or Departmental Specifications, such works shall be carried out in accordance with the relevant International Standards under the instructions and requirements of the Engineer-in-Charge.
Royalties	**7.18**	The Contractor shall pay all royalties, rents and other payments for: i natural Materials obtained from outside the Site, and ii disposal of materials from demolitions and excavations and of other surplus materials (whether natural or man-made), except to the extent that disposal areas within the Site are specified in the Contract. iii the liability, if any, on account of quarry fees, royalties, octroi and any other taxes and duties in respect of materials, actually consumed on public work shall be borne by the Contractor.
8. **Commencement, Delays and Suspension**		
Fixing center lines, reference points and bench marks.	**8.1**	The basic centre lines, reference points and benchmarks will be fixed by the by the Contractor and checked/confirmed by the Engineer-in-Charge. The Contractor shall establish at his own Cost at suitable points, additional reference lines and benchmarks as may be necessary and instructed by the Engineer-in-Charge. The Contractor shall remain responsible for the sufficiency and accuracy of all the benchmarks and reference lines.
Setting out of works.	**8.2**	The Contractor shall set out the Works in relation to original points, lines and levels of reference specified in the Contract or notified by the Engineer-in-Charge. The Contractor shall be responsible for the correct positioning of all parts of the Works, and shall rectify any error in the positions, levels, dimensions or alignment of the Works. The Procuring Entity shall be responsible for any errors in these specified or notified items of reference, but the Contractor shall use reasonable efforts to verify their accuracy before they are used. If the Contractor suffers delay and/or incurs Cost from executing work which was necessitated by an error in these items of reference, and an experienced contractor could not reasonably have discovered such error and avoided this delay and/ or Cost, the Contractor shall

		give notice to the Engineer-in-Charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i. an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion], and ii. payment of any such Cost, which shall be included in the Contract Price. After receiving this notice, the Engineer-in-Charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine (a) whether and (if so) to what extent the error could not reasonably have been discovered, and (b) the matters described in sub-paragraphs i and ii above related to this extent.
Commencement of Works	**8.3.1**	Except otherwise specified in the Contract Data/ Special Conditions of Contract, the Commencement Date shall be the date at which the following precedent conditions have all been fulfilled and the Engineer-in-charge's instruction recording the agreement of both Parties on such fulfilment and instructing to commence the Work is received by the Contractor: i signature of the Contract Agreement (after submission of Performance security and Insurance by the Contractor) by both Parties, and if required, approval of the Contract by relevant authorities; ii delivery to the Contractor of reasonable evidence of the Procuring Entity's Financial arrangements; iii except if otherwise specified in the Contract Data, possession of the Site given to the Contractor together with such permission(s) under (a) of Clause 2.1 [Right of Access to the Site] as required for the commencement of the Works; The Contractor shall commence the execution of the Works as soon as is reasonably practicable after the Commencement Date, and shall then proceed with the Works with due expedition and without delay. The date of commencement and stipulated completion shall be entered in the Contract Agreement.
	8.3.2	In case, the work cannot be started within one-fourth time of the stipulated period of completion of the Works due to reasons not within the control of the Contractor as decided by the Procuring Entity, either Party may close the Contract. In such eventuality, the Performance Security of the Contractor shall be refunded, but no payment on account of interest, loss of profit or damages etc. shall be payable at all.
Time for Completion	**8.4**	The Contractor shall complete the whole of the Works, and each Section (if any), within the Time for Completion for the Works or Section (as the case may be), including: i achieving the passing of the Tests on Completion, and ii completing all work which is stated in the Contract as being required for the Works or Section to be considered to be completed for the purposes of taking-over under Clause 12 [Taking Over of the Works and Sections]. iii completion of as built drawings and a manual for maintenance and operations, if required. iv completion of each mile stone as per the current (original updated every month) construction program. v rectification and or reconstruction of all deficient items of work or works /items of works for which 'Non Conformance Reports' were issued. vi restoration of the approach roads, fencing and appurtenant works damaged during execution of the Contracted project and clearance of Site. vii Operation and maintenance of the facilities viii The Contractor shall commence work on the Facilities within the period specified in the SCC and without prejudice to any GCC Subclause hereof, the Contractor shall thereafter proceed with the Facilities in accordance with the time schedule specified in the Appendix 2 (Time Schedule) to the Contract Agreement. ix The Contractor shall attain Completion of the Facilities or of a part where a

		separate time for Completion of such part is specified in the Contract, within the time stated in the SCC or within such extended time to which the Contractor shall be entitled under GCC Clause 40 hereof
Construction Programme ***(Activity Schedule in case of Lump Sum Contract)***	**8.5**	The Contractor shall submit a detailed execution time programme on MS Project or other similar software to the Engineer-in-charge within 28 Days after receiving the notice under Sub-Clause 8.3 [Commencement of Works]. The Contractor shall also submit a revised programme whenever the previous programme is inconsistent with actual progress or with the Contractor's obligations. Each programme shall be revised every month and shall include: i the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design (if any), drawings, Contractor's Documents, procurement, manufacture of Plant, delivery to Site, construction of works, erection and testing, ii each of these stages for work by each Sub-Contractor/ Nominated Sub-Contractor, iii the sequence and timing of quality and other inspections and tests specified in the Contract, and iv a supporting report which includes: a. a general description of the time, methods which the Contractor intends to adopt, and of the major stages, in the execution of the Works, and b. details showing the Contractor's reasonable estimate of the number of each class of Contractor's Personnel and of each type of Contractor's Equipment, required on the Site for each major stage. Unless the Engineer-in-charge, within 21 Days after receiving a programme, gives notice to the Contractor stating the extent to which it does not comply with the Contract, the Contractor shall proceed in accordance with the programme, subject to his other obligations under the Contract. The Procuring Entity's Personnel shall be entitled to rely upon the programme when planning their activities. The Contractor shall promptly give notice to the Engineer-in- charge of specific probable future events or circumstances which may adversely affect the Works, increase the Contract Price or delay the execution of the Works. The Engineer-in-charge may require the Contractor to submit an estimate of the anticipated effect of the future event or circumstances, and/or a proposal under Sub-Clause 9.2 [Deviations/ Variations Extent and Pricing]. If, at any time, the Engineer-in-charge gives notice to the Contractor that a programme fails (to the extent stated) to comply with the Contract or to be consistent with actual progress and the Contractor's stated intentions, the Contractor shall submit a revised programme to the Engineer-in-charge in accordance with this Sub-Clause.
Extension of Time for Completion	**8.6**	The Contractor shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to an extension of the Time for Completion if and to the extent that completion for the purposes of Clause 12 [Taking Over of the Works and Sections] is or will be delayed by any of the following causes: i. a Variation (unless an adjustment to the Time for Completion has been agreed under Clause 9 [Deviations, Variations and Adjustments] or other substantial change in the quantity/design of an item of work included in the Contract, ii. a cause of delay giving an entitlement to extension of time under a Sub-Clause of these Conditions, iii. exceptionally adverse climatic conditions, excluding the rains, high or low variations in temperatures, iv. Unforeseeable shortages in the availability of personnel or Goods caused by epidemic or Governmental actions, or v. any delay, impediment or prevention caused by or attributable to the Procuring Entity, the Procuring Entity's Personnel, or the Procuring Entity's

		other Contractors If the Contractor considers himself to be entitled to an extension of the Time for Completion, the Contractor shall give notice to the Engineer-in-charge in accordance with Sub-Clause 21.2 [Contractor's Claims]. When determining each extension of time under Sub-Clause 3.5 [Determinations], the Engineer-in-charge shall review previous determinations and may increase, but shall not decrease, the total extension of time.
Delays Caused by Authorities	**8.7**	If the following conditions apply, namely: i. the Contractor has diligently followed the procedures laid down by the relevant legally constituted public authorities in the Country, ii. these authorities delay or disrupt the Contractor's work, and iii. the delay or disruption was Unforeseeable, Then this delay or disruption will be considered as a cause of delay under Sub-Clause 8.6 [Extension of Time for Completion].
Rate of progress of works.	**8.8**	As soon as possible after the Contract is concluded the Contractor shall submit a time and progress chart (preferably on MS Project or other similar software) for each milestone and get it approved by the Engineer-in-Charge. 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 tasks 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 complete the work as per milestone. If, at any time: i. actual progress is too slow to complete within the Time for Completion, and/or progress has fallen (or will fall) behind the current programme under Sub-Clause 8.5 [Construction Programme], other than as a result of a cause listed in Sub-Clause 8.6 [Extension of Time for Completion], then the Engineer-in-charge may instruct the Contractor to submit, under Sub-Clause 8.5 [Construction Programme], a revised programme and supporting report describing the revised methods which the Contractor proposes to adopt in order to expedite progress and complete within the Time for Completion. ii. Unless the Engineer-in-Charge notifies otherwise, the Contractor shall adopt these revised methods, which may require increases in the working hours and/or in the numbers of Contractor's Personnel and/or Goods, at the risk and Cost of the Contractor. If these revised methods cause the Procuring Entity to incur additional Costs, the Contractor shall subject to notice under Sub-Clause 2.5 [Procuring Entity's Claims] pay these Costs to the Procuring Entity, in addition to delay damages (if any) under Sub-Clause 8.9 below. iii. Additional Costs of revised methods including acceleration measures, instructed by the Engineer-in-charge to reduce delays resulting from causes listed under Sub-Clause 8.6 [Extension of Time for Completion] shall be paid by the Procuring Entity, without generating, however, any other additional payment benefit to the Contractor If the progress of the work has fallen so much in arrears as to prevent other contractors on the work from carrying out their part of the work within the stipulated time, he will be liable for the settlement of any claim put in by any of these contractors for the expenses of keeping their labour unemployed to the extent considered reasonable by the Engineer-in-charge.
Compensation/ Damages for Delay (Liquidated Damage)	**8.9**	i If the Contractor fails to maintain the required progress in terms of Sub-Clause 8.4 [Extension of Time for Completion] or to complete the Works and clear the Site on or before the original or extended date of completion, he shall, without prejudice to any other right or remedy available under the Law to the Government/ procuring Entity on account of such breach, pay as

(In case of Lump Sum Contract, the liquidated damages shall be linked to Stage wise completion of Works as stated in Activity Schedule and specified in SCC)

agreed compensation the amount calculated at the rates stipulated below as the Engineer-in-charge (whose decision in writing shall be final and binding) may decide on the amount of contracted value of the Works for every time span that the progress remains below that specified in Sub-Clause 8.4 [Extension of Time for Completion] or that the Works remains incomplete. This will also apply to items or group of items for which a separate period of completion has been specified.

ii To ensure good progress during the execution of Works, the Contractor shall be bound, in all cases in which the time allowed for any Works exceeds one month (save for special jobs or where time spans have been fixed in light of the specific construction program), to complete 1/8th of the whole of the work before 1/4th of the whole time allowed under the contract has elapsed, 3/8th of the work before 1/2 of such time has elapsed and 3/4th of the work before 3/4 of such time has elapsed. If the Contractor fails to complete the work in accordance with this time schedule in terms of cost in money, and the delay of execution of Works is attributable to the Contractor, the Contractor shall be liable to pay compensation to the Government/ Procuring Entity at every time span as below:-

A.	Time Span of full stipulated period	1/4th	1/2th	3/4th	Full
B.	Work to be completed in terms of money	1/8th (Rs)	3/8th (Rs)	3/4th (Rs)	Full (Rs)
C	Compensation payable by the Contractor for delay attributable to Contractor at the stage of	• Delay up to one fourth period of the prescribed time span – 2.5% of the work remained unexecuted. • Delay exceeding one fourth of the prescribed time span but not exceeding half of the prescribed time span - 5% of the work remained unexecuted. • Delay exceeding half of the prescribed time span but not exceeding three fourth of the prescribed time span - 7.5% of the work remain unexecuted. • Delay exceeding three fourth of the prescribed time span – 10% of the work unexecuted.			

Note-1: In case delayed period over a particular time span is split up and is jointly attributable to the Procuring Entity and the Contractor, the competent authority may reduce the compensation in proportion of delay attributable to the Procuring Entity over entire delayed period over that time span after clubbing up the split delays attributable to the Procuring Entity and this reduced compensation would be applicable over the entire delayed period without paying any escalation.

Note-2: The compensation, levied as above, shall be recoverable from the Payment Certificate payable after the concerned time span. The total compensation for delays shall, however, not exceed10 percent of the total value of the Works.

iii The Contractor shall further be bound to carry out the work in accordance with the date and quantity entered in the progress statement attached to the Bid.

iv However, if a time schedule has been submitted by the Contractor before

		execution of the agreement, and it is entered in agreement as submitted or as modified by the Procuring Entity or the Engineer-in-Charge, the Contractor shall complete the Works within the said time schedule. In the event of the Contractor failing to comply with the time schedule, he shall be liable to pay compensation as prescribed in foregoing paragraph of this Sub-Clause. While granting extension in time attributable to the Procuring Entity, reasons shall be recorded for each delay. v The amount of compensation may be adjusted or set off against any sum payable to the Contractor under this or any Contract with the Procuring Entity. In case, the Contractor does not achieve a particular milestone mentioned in Contract Data or the rescheduled milestone(s), the amount shown against that milestone shall be withheld, to be adjusted against the compensation levied at the final grant of extension of time. vi 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 subsequent also shall be withheld. However, no interest, whatsoever, shall be payable on such withheld amount. vii If the Contract is completed in the original time period as agreed upon in the Contract, then the Liquidated Damages so imposed for delays of intermediate milestones will be adjusted/ paid. Also, price escalation shall not be applicable if Liquidated Damages have been imposed. However, if the Contractor finishes the work as per the original time period, he shall be eligible to receive the price escalation.
Suspension of Work	**8.10.1**	8.10.1.1 The Employer may request the Project Manager, by notice to the Contractor, to order the Contractor to suspend performance of any or all of its obligations under the Contract. Such notice shall specify the obligation of which performance is to be suspended, the effective date of the suspension and the reasons therefor. The Contractor shall thereupon suspend performance of such obligation, except those obligations necessary for the care or preservation of the Facilities, until ordered in writing to resume such performance by the Project Manager. If, by virtue of a suspension order given by the Project Manager, other than by reason of the Contractor's default or breach of the Contract, the Contractor's performance of any of its obligations is suspended for an aggregate period of more than 90 days, then at any time thereafter and provided that at that time such performance is still suspended, the Contractor may give a notice to the Project Manager requiring that the Employer shall, within 28 days of receipt of the notice, order the resumption of such performance or request and subsequently order a change in accordance with GCC Clause 37, excluding the performance of the suspended obligations from the Contract. If the Employer fails to do so within such period, the Contractor may, by a further notice to the Project Manager, elect to treat the suspension, where it affects a part only of the Facilities, as a deletion of such part in accordance with GCC Clause 38 or, where it affects the whole of the Facilities, as termination of the Contract under GCC Subclause 17 8.10.1.2 If

		(a) the Employer has failed to pay the Contractor any sum due under the Contract within the specified period, has failed to approve any invoice or supporting documents without just cause pursuant to the Appendix (Terms and Procedures of Payment) to the Contract Agreement, or commits a substantial breach of the Contract, the Contractor may give a notice to the Employer that requires payment of such sum, with interest thereon as stipulated in GCC Subclause 18.3, requires approval of such invoice or supporting documents, or specifies the breach and requires the Employer to remedy the same, as the case may be. If the Employer fails to pay such sum together with such interest, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, or fails to remedy the breach or take steps to remedy the breach within 14 days after receipt of the Contractor's notice; or (b) the Contractor is unable to carry out any of its obligations under the Contract for any reason attributable to the Employer, including but not limited to the Employer's failure to provide possession of or access to the Site or other areas in accordance with GCC Subclause 18.3, or failure to obtain any governmental permit necessary for the execution and/or completion of the Facilities, then the Contractor may by 14 days' notice to the Employer suspend performance of all or any of its obligations under the Contract, or reduce the rate of progress. 8.10.1.3 If the Contractor's performance of its obligations is suspended, or the rate of progress is reduced pursuant to this GCC Clause 8.10, then the Time for Completion shall be extended in accordance with GCC Subclause 39.1, and any and all additional costs or expenses incurred by the Contractor as a result of such suspension or reduction shall be paid by the Employer to the Contractor in addition to the Contract Price, except in the case of suspension order or reduction in the rate of progress by reason of the Contractor's default or breach of the Contract. 8.10.1.4 During the period of suspension, the Contractor shall not remove from the Site any Plant, any part of the Facilities or any Contractor's Equipment, without the prior written consent of the Employer.
	8.10.2	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: i. on account of any default on the part of the Contractor; or ii. for proper execution of the Works or part thereof for reasons other than the default of the Contractor; or iii. for safety of the Works or part thereof. The Contractor shall, carry out the instructions given in that behalf by the Engineer-in-Charge. If the suspension is ordered for reasons ii and iii above, the Contractor shall be entitled to an extension of time equal to the period of every such suspension 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,

Consequences of Suspension	**8.11**	If the Contractor suffers delay and/ or incurs Cost from complying with the Engineer-in-charge's instructions under Sub-Clause 8.10 [Suspension of Work] and/ or from resuming the work, the Contractor shall give notice to the Engineer-in- charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i. An extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion], and ii. payment of any such Cost, which shall be included in the Contract Price. After receiving this notice, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters. The Contractor shall not be entitled to an extension of time for, or to payment of the Cost incurred in making good the consequences of the Contractor's faulty design, workmanship or Materials, or of the Contractor's failure to protect, store or secure the work in accordance with Sub-Clause 8.10 [Suspension of Work].
Payment for Plant and Materials in Event of Suspension	**8.12**	The Contractor shall be entitled to payment of the value (as at the date of suspension) of Plant and/ or Materials which have not been delivered to Site, if: i. the work on Plant or delivery of Plant and/ or Materials has been suspended for more than 28 Days, and ii. The Contractor has marked the Plant and/ or Materials as the Procuring Entity's property in accordance with the Engineer-in-charge's instructions.
Prolonged Suspension	**8.13**	If the suspension under Sub-Clause 8.10 [Suspension Work] has continued for more than 84 Days, the Contractor may request the Engineer-in-charge's permission to proceed. If the Engineer-in- charge does not give permission within 28 Days after being requested to do so, the Contractor may, by giving notice to the Engineer-in-charge, treat the suspension as an omission under Sub-Clause 9.2 [Deviations/ Variations Extent and Pricing] of the affected part of the Works. If the suspension affects the whole of the Works, the Contractor may give notice of termination under Sub-Clause 17.2 [Termination by Contractor].
Resumption of Work	**8.14**	After the permission or instruction to proceed is given, the Contractor and the Engineer-in-charge shall jointly examine the Works and the Plant and Materials affected by the suspension. The Contractor shall make good any deterioration or Defect in or loss of the Works or Plant or Materials, which has occurred during the suspension after receiving from the Engineer-in- charge an instruction to this effect under Sub-Clause 9.2 [Deviations/ Variations, Extent and Pricing].
Work to be executed strictly as per specifications	**8.15**	All Works under or in course of execution or executed in pursuance of the Contract shall at all times be executed strictly as per specifications of the Contract as established by regular testing at the specified frequency and be open and accessible to the quality inspection and supervision of the Engineer-in-Charge, his authorized subordinates in charge of the work and all the superior officers, officers of the Quality Control Organization, Third Party Inspection Agency, if engaged by the Procuring Entity, 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 written orders and instructions or 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. All payments shall be linked to the specified quality of works and works failing on tests or not executed as per design, drawings and specifications shall not be paid unless rectified to the specified quality by the Contractor.
Action when Work executed with unsound materials, imperfect and	**8.16**	If it shall be established through regular testing or post execution quality testing by the third party quality inspection agency to the Engineer-in-Charge or his higher authority or his authorized subordinates in charge of the Works, that any work has been executed with unsound, imperfect, or unskilled workmanship, or with Materials or articles provided by him for the execution of the work which are unsound or of a quality inferior to that contracted or otherwise not in

unskilled workmanship		accordance with the Contract, the Contractor shall, on demand in writing 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 reconstruct, 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 for the specified period, at the same rate as under Sub-Clause 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 of the 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.
9. Deviations, variations and adjustments		
Right to Vary ***(Additions and Alterations in case of Lump Sum Contract)***	**9.1**	Variations may be initiated by the Engineer-in-charge at any time during the execution of the Works prior to issuing the Taking-Over Certificate for the Works, either by an instruction or by a request for the Contractor to submit a proposal. The Contractor shall execute and be bound by each Variation, unless the Contractor promptly gives notice to the Engineer-in- charge stating (with supporting particulars) that: i. the Contractor cannot readily obtain the Goods required for the Variation, or ii. such Variation triggers a substantial change in the sequence or progress of the Works. Upon receiving this notice, the Engineer-in-charge shall cancel, confirm or vary the instruction. Each Variation may include: i. changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation), ii. changes to the quality and other characteristics of any item of work, iii. changes to the levels, positions and/ or dimensions of any part of the Works, iv. omission of any work unless it is to be carried out by others, v. any additional work, Plant, Materials or services necessary or incidental to the Works, including any associated Tests on Completion, boreholes and other testing and exploratory work, vi. Changes to the sequence or timing of the execution of the Works. The Contractor shall not make any alteration and/ or modification of the Permanent Works, unless and until the Engineer-in-charge instructs or approves a Variation.
Deviations/ Variations Extent and Pricing	**9.2.1**	The Engineer-in-charge shall have power (i) to make alternations in, omissions from, additions to, or substitutions for the original Specifications, quantities, Drawings, designs and instructions that may be appear to him to be necessary or advisable during the progress of the Works, 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.
(In case of Lump Sum Contract, Rates of measured up additions and alterations shall be as per applicable BSR or rates of Day Work given be the Contractor and forming part of the Contract)	**9.2.2**	The rates for such additional, altered or substituted works shall be determined in accordance with the following provisions: i. If the rates for the additional, altered or substituted work are specified in the Contract for the Works, the Contractor is bound to carry out the additional, altered or substituted work at the same rates as are specified in the Contract for the Works. ii. If the rates for the additional, altered or substituted work are not specifically provided in the Contract for the Works, such rates will be derived from the rates for a similar class of work as are specified in the Contract for the Works. iii. If the rates for the additional, altered or substituted work cannot be determined in the manner specified in the sub-clauses i and ii above, then the rates for such composite work item shall be worked out on the basis of the concerned Schedule of Rates of the district/ area specified above minus/ plus the percentage which the total Bid amount bears to the estimated cost of the entire Works put to bid. Provided always that if the rate for such part or parts of the item is not in the Schedule of Rates, the rate for such part or parts will be determined by the Engineer-in-charge on the basis of the prevailing market rates when the work was done but the percentage of bid discount/ premium will not be subtracted/ added to such market rates. iv. If the rates for the additional, altered or substituted work item cannot be determined in the manner specified in sub sub-clause I to iii above then the contractor shall within 7 days of the date of receipt of order to carry out the work, inform the Engineer-in-charge of the rate which it is his intention to charge for such class of work supported by analysis of the rate(s) claimed and the Engineer-in-charge shall determine the rate/ rates on the basis of prevailing market rates and pay the contractor accordingly. However, the Engineer-in-charge, by notice in writing, will be at liberty to cancel his order to carry out such class of work and arrange to carry it out in such manner as he may consider advisable but under no circumstances, the Contractor shall suspend the work on the plea of non-settlement of rates on items falling under this sub-clause.
	9.2.3	The quantum of additional work for each item shall not exceed 50% of the original quantity of the item given in the Contract and the total value of additional, altered, and substituted items of work shall not exceed 50% of the Accepted Contract Price. ***(This para is not applicable in case of Lump Sum Contract)***
	9.2.4	The time for completion of the Works shall in the event of any deviations resulting in additional Cost over the Contract Price being ordered be extended if requested by the Contractor in the proportion which the additional Cost of the altered, additional or substituted work, bears to the original Contract Price. Similarly, the proportionate time period for an item of work deleted shall be reduced from the total time period provided in the Contract.
Value Engineering	**9.3**	The Contractor may, at any time, submit to the Engineer-in-charge a written proposal which (in the Contractor's opinion) will, if adopted, (i) accelerate completion, (ii) reduce the Cost to the Procuring Entity of executing, maintaining or operating the Works, (iii) improve the efficiency or value to the Procuring Entity of the completed Works, or (iv) otherwise be of benefit to the Procuring Entity The proposal shall be prepared at the Cost of the Contractor and shall include the items listed in Sub-Clause 9.2 [Deviations, Variations and Pricing]. If a proposal, which is approved by the Engineer-in-charge, includes a change in the design of part of the Permanent Works, then unless otherwise agreed by both Parties: i. the Contractor shall design this part,

		ii. Sub-Clause 4.1[Contractor's General Obligations] shall apply, and iii. If this change results in a reduction in the Contract value of this part, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine a fee, which shall be included in the Contract Price.
No compensation for alterations in or restriction of works to be carried out	**9.4**	If, at any time after the commencement of the Works, the Procuring Entity shall, for any reason, whatsoever, not require the whole Works, thereof, as specified in the Contract, to be carried out, the Engineer-in-charge shall give notice, in writing, of the fact to the Contractor, who shall have no claim to any payment or compensation, 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 full amount of the Works not having been carried out. Neither shall he have any claim for compensation by reason of alterations having been made in the original specifications, drawings and design and instructions, which shall involve any curtailment of the Works, as originally contemplated. Provided, that the contractor shall be paid the charges for the cartage only, of Materials actually brought to the Site of the Works by him for bonafide use and rendered surplus as a result of the abandonment or curtailment of the Works or any portion thereof, and taken them back by the Contractor, provided, however, that the Engineer-in-charge shall have, in all such cases, the option of taking over all or any such Materials at their purchase price or at local market rates whichever may be less. In the case of such stores, having been issued from Procuring Entity's Stores, charges recovered, including storage charges shall be refunded after taking into consideration any deduction for claim on account of any deterioration or damage while in the custody of the Contractor and in this respect the decision of the Engineer-in-charge shall be final.
Monthly Return of Extra Claims	**9.5.1**	To facilitate timely resolution of Contractor's claims due against the orders/ instructions of the Engineer-in-Charge, the Contractor shall submit every month along with the Intermediate Payment Claims, a comprehensive statement of claims raised by him for any work claimed as extra, up to the previous month and awaiting resolution by the Engineer-in-Charge and/ or Procuring Entity. Value of claims shall be based upon the rates and prices mentioned in the Contract or in the Schedule of Rates in force in the District/ Division/ Circle for the time being. The Engineer-in-Charge shall duly acknowledge it and proceed to act as per Sub-Clause 3.5 [Determinations]. He will communicate the resolution to the Contractor and also reasons for rejection to the Contractor's claims. The contractor shall be deemed to have waived all claims, not included in such return and will have no right to enforce any such claims not included, whatsoever be the circumstances. However, the Contractor shall continue performance on the Contract despite rejection of his claims by the Engineer-in-Charge. Such rejected claims may then be raised before the Dispute Resolution Board or the Arbitration Tribunal, as appropriate.
	9.5.2	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 .
	9.5.3	Any operation or procedure incidental to or necessary to the execution of the Works has to be in contemplation of Bidder while submitting his Bid, 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 Bidder or the rate given in the said schedule of rates, as the case may be. Nothing extra shall be admissible for such operations/ procedures.
Provisional Sums	**9.6**	Each Provisional Sum shall only be used, in whole or in part, in accordance with the Engineer-in-charge's instructions and the Contract Price shall be adjusted

		accordingly. The total sum paid to the Contractor shall include only such amounts, for the work, supplies or services to which the Provisional Sum relates, as the Engineer-in-charge shall have instructed. For each Provisional Sum, the Engineer-in-charge may instruct: i. work to be executed (including Plant, Materials, labour or services to be supplied) by the Contractor and valued; and/ or ii. Plant, Materials or services to be procured by the Contractor from a Nominated Sub-Contractor as defined in Sub-Clause 5.2 [Nomination of Sub-Contractor] or otherwise; and for which there shall be included in the Contract Price: (a) the actual amounts paid (or due to be paid) by the Contractor, and (b) A sum for overhead charges, calculated at 10% percent of these actual amounts. The amount of overheads (10%) shall be subject to tax liability as per law. The Contractor shall, when required by the Engineer-in-charge, produce invoices, vouchers and accounts or receipts in substantiation.
Day Work	**9.7**	For works of a minor or incidental nature, the Engineer-in-charge may instruct that a Variation shall be executed on a Day work basis. The work shall then be valued in accordance with the Day work Schedule included in the Contract, and the following procedure shall apply. If a Day work Schedule is not included in the Contract, this Sub-Clause shall not apply. Before ordering materials for the work, the Contractor shall submit quotations to the Engineer-in-charge. When applying for payment, the Contractor shall submit invoices, vouchers and accounts or receipts for any Materials/ Equipment/ Plant/ Temporary Works. Except for any items for which the Day work Schedule specifies that payment is not due, the Contractor shall deliver each day to the Engineer-in-charge accurate statements in duplicate which shall include the following details of the resources used in executing the previous day's work: i. the names, occupations, day wages and required time period of Contractor's Personnel, ii. the identification, type and time of Contractor's Equipment and Temporary Works, and iii. The quantities and types of Plant and Materials used. One copy of each statement will, if correct, or when agreed, be signed by the Engineer-in-charge and returned to the Contractor. The Contractor shall then submit priced statements of these resources to the Engineer-in-charge, prior to their inclusion in the next Statement under Sub-Clause 15.5 [Issue of Interim Payment Certificates].
10. Price Variation		
Price Variation due to changes in the prices of labour, materials, bitumen, petroleum, cement and steel	**10.1**	If, during the progress of the contract of value exceeding Rs. 50 lakh (accepted Contract Price minus cost of material supplied by the Procuring Entity), and where stipulated completion period is more than 3 months (both the conditions should be fulfilled), the price, of any materials/ bitumen/ diesel and petrol/ cement/ steel incorporated in the Works (not being materials to be supplied by the Procuring Entity) and/ or wages of labour increases or decreases, as compared to the price and/ or wages prevailing at the date of opening of bids or date of negotiations for the Works, the amounts payable to Contractor for the Works shall be adjusted for increase or decrease in the rates of materials (excepting those materials supplied by the Procuring Entity)/ labour/ bitumen /diesel and petrol/ cement/ steel. If negotiated rates have been accepted, prices as on the date of negotiation shall be considered for price adjustment. Similarly, if rates received on the date of opening of bids have been accepted, then prices on the date of opening of bids shall be considered for price adjustment.
		(c.) Credit the cost of materials, hire charges of Contractor's plant and machinery if

		Increase or decrease in the cost of labour/ material/ diesel and petrol/ cement/ steel shall be calculated quarterly and cost of bitumen shall be calculated on monthly basis in accordance with the following formula:- **(A) Labour** $V_L = 0.75 \times \frac{P_L}{100} \times R \frac{(I_{L1} - I_{L0})}{I_{L0}}$ Where, V_L = Increase or decrease in the cost of Works during the quarter under consideration due to change in rates for labour. R = The value of the Works done in rupees during the quarter under consideration excluding the cost of materials supplied by the Procuring Entity and excluding other items as mentioned in this Sub-Clause. I_{L0}= The average consumer price index for industrial workers (whole-sale prices) for the quarter in which bids were opened/ negotiated (as published in Reserve Bank of India Journal, for the area). I_{L1}= The average consumer price index for industrial workers (whole-sale prices) for the quarter of calendar year under consideration (as published in Reserve Bank of India Journal, for the area). P_L= Percentage of labour components. Note: In case of revision of minimum wages by the Government or other competent authority, nothing extra would be payable except the price escalation permissible under this Sub-Clause. **(B) Materials** (excluding materials supplied by the Procuring Entity). $V_M = 0.75 \times \frac{P_M}{100} \times R \frac{(L_{M1} - L_{M0})}{L_{M0}}$ Where, V_M = Increase or decrease in the cost of Works during the quarter under consideration due to change in rates for materials. R = The value of the Works done in rupees during the quarter under consideration excluding the cost of materials supplied by the Procuring Entity and excluding other items as mentioned in this Sub-Clause. L_{M0} = The average wholesale price index (all commodities) for the quarter in which bids were opened/ negotiated (as published in Reserve Bank of India Journal/ Economic Adviser to Government of India, Ministry of Industries, for the area). L_{M1} = The average wholesale price index (all commodities) for the quarter under consideration (as published in Reserve Bank of India Journal/ Economic Adviser to Government of India, Ministry of Industries, for the area). P_M= Percentage of materials components (excluding materials supplied by the Procuring Entity). **(C) Bitumen** $V_b = 0.85 \times \frac{P_b}{100} \times R \frac{(B_i - B_0)}{B_0}$ Where, V_b = Increase or decrease in the cost of Works during the month under consideration due to changes in the rate for bitumen. R = The value of the Works done in rupees during the month under consideration excluding the cost of materials supplied by the Procuring Entity and excluding other items as mentioned in this Sub-Clause. B_0 = The official retail price of bitumen at the IOC depot at nearest center on the day 28 days prior to date of opening of Bids. B_i = The official retail price of bitumen of IOC depot at nearest center for the 15th day of the month under consideration.

		P_b = Percentage of bitumen components of the Works.] **(D) Petroleum** $V_f = 0.75 \times \frac{P_f}{100} \times R \frac{(F_i - F_0)}{F_0}$ Where, V_f = Increase or decrease in the cost of Works during the quarter under consideration due to change in rates for fuel and lubricants. R = The value of the Works done in rupees during the quarter under consideration excluding the cost of materials supplied by the Procuring Entity and excluding other items as mentioned in this Sub-Clause. F_0 = The average wholesale price index of High Speed Diesel (HSD) as published by the Economic Adviser to the Government of India, Ministry of Industry on the day of opening of bids/ negotiations. F_i = The average whole sale price Index of HSD for the quarter under consideration as published weekly by the Economic Adviser to the Government of India, Ministry of Industry for the quarter under consideration. P_f = Percentage of fuel and lubricants components excluding fuel and lubricants supplied by the Procuring Entity (Specified in the sanctioned estimate for the Works). R = Total Works done during the quarter as prescribed under this Sub-Clause. Note: For application of this Sub-Clause price of HSD is chosen to indicate fuel and lubricants components. **(E) Cement** $V_C = 0.75 \times \frac{P_C}{100} \times R \frac{(L_{C1} - L_{C0})}{L_{C0}}$ Where, V_C = Increase or decrease in the cost of Works during the quarter under consideration due to change in the rates of cement. R = The value of the Works done in rupees during the quarter under consideration excluding the cost of cement supplied by the Procuring Entity and excluding other items as mentioned in this Sub-Clause. L_{C0} = The average wholesale price index for the quarter in which bids were opened/ negotiated (as published by the Economic Adviser to the Government of India, Ministry of Industries). L_{C1} = The average whole sale price Index for the quarter under consideration (as published by the Economic Adviser to Government of India, Ministry of Industries). P_C = Percentage of cement components (excluding cement supplied by the Procuring Entity). **(F) Steel** $V_S = 0.75 \times \frac{P_S}{100} \times R \frac{(L_{S1} - L_{S0})}{L_{S0}}$ Where, V_S = Increase or decrease in the cost of Works during the quarter under consideration due to change in the rates of steel. R = The value of the Works done in rupees during the quarter under consideration excluding the cost of steel supplied by the Procuring Entity and excluding other items as mentioned in this Sub-Clause. L_{S0} = The average wholesale price index for the quarter in which bids were opened/ negotiated (as published by the Economic Adviser to the Government of India, Ministry of Industries).

		L_{SI} = The average wholesale price Index for the quarter under consideration (as published by the Economic Adviser to Government of India, Ministry of Industries). P_S = Percentage of steel components (excluding steel supplied by the Procuring Entity).
Price Variation in installation of elevators, supply /installation of Centrally Air Conditioning and Central Evaporating Cooling Works.	**10.2**	In all cases of contracts for installation of elevators, supply/ installation of Central Air Conditioning and Central Evaporating Cooling Works, the price quoted shall be based on the Indian Electrical and Electronics Manufacturers Association (IEEMA) price variation Sub-Clause based on the cost of raw materials/ components and labour cost as on the date of quotation/ bid, and the same is deemed to be related to wholesale price index number of metal products and All India Average consumer price index number of industrial workers as specified below. In case of any variation in these index numbers, the prices shall be subject to adjustment up or down in accordance with following formula: $$P = \frac{P_O}{MP_0}\left[15 + 55\,\frac{MP}{W_0} + 15\,\frac{W_O(D)}{W_0} + 15\,\frac{W_O(1)}{W_0}\right] \quad 100$$ Where, P = Price payable as adjusted in accordance with the above price variation formula. P_0 = Price quoted/ confirmed. MP_0 = Wholesale Price Index Number for Metal Products as published by the office of the Economic Adviser, Ministry of Industry, Government of India, in their weekly bulletin, Revised Index Number of Wholesale Prices (Base: 1981- 82 = 100) for the week ending first Saturday of the relevant calendar month. The relevant month shall be that in which price was offered or negotiated whichever is later. W_0 = All India Average Consumer Price Index Number for Industrial workers (Base : 1982 = 100), as published by Labour Bureau, Ministry of Labour, Government of India, for relevant calendar month. The relevant month shall be that in which price was offered or negotiated whichever is later. The above index number MP_0& W_0 are those published by IEEMA as prevailing on the first working day of the calendar month FOUR months prior to the date of bidding. MP = Wholesale Price Index Number for Metal Products as published by the office of the Economic Adviser, Ministry of Industry, Government of India, in their weekly bulletin Revised Index Number of Wholesale Prices (Base: 1981-82 = 100). The applicable wholesale price Index Number for Metal Products as prevailing on 1st Saturday of the month covering the date FOUR months prior to .the date of delivery and would be as published by IEEMA. $W_O(D)$ = AII India Average Consumer Price Index Number for Industrial Workers prevailing for the month covering the date FOUR months prior to the date of delivery of manufactured material and would be as published by IEEMA. $W_O(1)$ = All India Average Consumer Price Index Number for Industrial Workers (Base : 1982 = 100) as published by Labour Bureau, Ministry of Labour, Government of India. The applicable All India Consumer Price Index Number of Industrial Workers prevailing for the FOUR months prior to the date of completion of installation/ progress parts of installation and would be as published by IEEMA. The date of delivery shall be the date on which the manufactured material is actually supplied at Site. The date of completion of installation (or progress part of installation) shall be the date on which the Works is notified as being completed and is available for inspection/ duly tested. In the absence of such notification, the date of completion is not

		intimated, such completion shall be considered by the Engineer In-charge which shall be final. **Note-1** The Wholesale Price Index Number for Metal Products is published weekly by the office of the Economic Adviser, but if there are any changes, the same are incorporated in the issue appearing in the following week. For the purpose of this Price Variation Sub-Clause, the final index figures shall apply. **Note-2** The sole purpose of the above stipulation is to arrive at the entire Contract under the various situations. The above stipulation does not indicate any intentions to sell materials under this Contract as movables. **Note-3** The indices MP & Wo are regularly published by IEEMA in monthly basic price circulars based on information bulletins from the authorities mentioned. These will be used for determining price variation and only IEEMA Circulars will be shown as evidence, if required.
General Conditions for admissibility of Price Variation	**10.3**	The General Conditions for admissibility of Price Variation are given in **Appendix A** to these General Conditions.
11. Tests on completion		
Contractor's obligations	**11.1**	The Contractor shall carry out the Tests on Completion in accordance with the BIS/ IRC and other standard codes and Sub-Clause 7.9 [Testing], after providing the documents in accordance with the requirements for tests on completion. The Contractor shall give to the Engineer-in-charge not less than 15 Days' notice of the date after which the Contractor will be ready to carry out each of the Tests on Completion. Unless otherwise agreed, Tests on Completion shall be carried out within 7 Days after this date, on such day or Days as the Engineer-in- charge shall instruct. In considering the results of the Tests on Completion, the Engineer-in-charge shall make allowances for the effect of any use of the Works by the Procuring Entity on the performance or other characteristics of the Works. As soon as the Works, or a Section, have passed any Tests on Completion, the Contractor shall submit a certificate of the results of these Tests to the Engineer-in-charge.
Delayed Tests	**11.2**	If the Tests on Completion are being unduly delayed by the Engineer-in-charge, Sub-Clause 7.9.2 of 7.9 [Testing] shall be applicable. If the Tests on Completion are being unduly delayed by the Contractor, the Engineer-in-charge may by notice require the Contractor to carry out the Tests within 21 Days after receiving the notice. The Contractor shall carry out the Tests on such day or Days within that period as the Contractor may fix and of which he shall give notice to the Engineer-in-charge. If the Contractor fails to carry out the Tests on Completion within the period of 21 Days, the Procuring Entity's/ Engineer-in-Charge's Personnel may proceed with the Tests at the field laboratory or at an outsourced laboratory at the risk and cost of the Contractor. The Tests on Completion shall then be deemed to have been carried out in the presence of the Contractor and the results of the Tests shall be accepted as accurate and binding on the Contractor.
Retesting	**11.3**	If the Works, or a Section, fails to pass the Tests on Completion, Sub-Clauses 7.13 [Rejection] and 11.4 [Failure to Pass Tests on Completion] shall apply, and the Engineer-In-Charge or the Contractor may require the failed Tests, and Tests on Completion on any related work, to be repeated under the same terms and conditions.
Failure to Pass Tests on Completion	**11.4**	If the Works, or a Section, fails to pass the Tests on Completion repeated under Sub-Clause 11.3 [Retesting], the Engineer-in-Charge shall be entitled to: i. Order further repetition of Tests on Completion; ii. If failure deprives the Procuring Entity of substantially the whole benefit of the Works or Section, reject the Works or Section (as the case may be), in
		used in the remedial work.

		which event the Procuring Entity shall have the same remedies as provided in Sub-paragraph (c) of Sub-Clause 13.6 [Failure to Remedy Defect]; or iii. Issue a Taking-Over Certificate, if the Procuring Entity so requires. In the event of Sub-para iii, the Contractor shall proceed in accordance with all other obligations under the Contract, and the Contract Price shall be reduced by such amount as shall be appropriate to cover the reduced value to the Procuring Entity as a result of this failure. Unless the relevant reduction for this failure is stated (or its method of calculation is defined) in the Contract, the Procuring Entity may require the reduction to be (i) agreed by the Contractor (in full satisfaction of this failure only) and paid before this Taking-Over certificate is issued, or (ii) determined and paid under Sub-Clause 3.5 [Determinations].
12. Taking over of the Works and Sections by Procuring Entity		
Taking over of works.	**12.1**	Except as stated in Sub-Clause 11.4 [Failure to Pass Tests on Completion], the Works shall be taken over by the Procuring Entity when (a) the Works have been completed in accordance with the Contract, including the matters described in Sub-Clause 8.4 [Time for Completion] and except as allowed in sub-paragraph i. below, and (b) a Taking-Over Certificate for the Works has been issued, or is deemed to have been issued in accordance with this Sub-Clause. The Contractor may apply by notice to the Engineer-in-charge for a Taking-Over Certificate not earlier than 14 Days before the Works will, in the Contractor's opinion, be complete and ready for taking over. If the Works are divided into Sections, the Contractor may similarly apply for a Taking-Over Certificate for each Section. The Engineer-in-charge shall, within 28 Days after receiving the Contractor's application: i. issue the Taking-Over Certificate to the Contractor, stating the date on which the Works or Section was completed in accordance with the Contract, except for any minor outstanding work and Defects which will not substantially affect the use of the Works or Section for their intended purpose (either until or whilst this work is completed and these Defects are remedied); or ii. reject the application, giving reasons and specifying the work required to be done by the Contractor to enable the Taking-Over Certificate to be issued. The Contractor shall then complete this work before issuing a further notice under this Sub-Clause. If the Engineer-in-charge fails either to issue the Taking-Over Certificate or to reject the Contractor's application within the period of 28 Days, and if the Works or Section (as the case may be) are substantially in accordance with the Contract, the Taking-Over Certificate shall be deemed to have been issued on the last day of that period.
Taking over of Parts of the Works	**12.2**	The Engineer-in-charge may, at the sole discretion of the Procuring Entity, issue a Taking-Over Certificate for any part of the Permanent Works. The Procuring Entity shall not use any part of the Works (other than as a temporary measure which is either specified in the Contract or agreed by both Parties) unless and until the Engineer-in-charge has issued a Taking-Over Certificate for this part. However, if the Procuring Entity does use any part of the Works before the Taking-Over Certificate is issued: i. the part which is used shall be deemed to have been taken over as from the date on which it is used, ii. the Contractor shall cease to be liable for the care of such part as from this date, when responsibility shall pass to the Procuring Entity, and iii. if requested by the Contractor, the Engineer-in-charge shall issue a Taking-Over Certificate for this part. After the Engineer-in-charge has issued a Taking-Over Certificate for a part of the Works, the Contractor shall be given the earliest opportunity to take such steps as may be necessary to carry out any outstanding Tests on Completion.

		The Contractor shall carry out these Tests on Completion as soon as practicable before the expiry date of the relevant Defects Notification Period. If the Contractor incurs Cost as a result of the Procuring Entity taking over and/ or using a part of the Works, other than such use as is specified in the Contract or agreed by the Contractor, the Contractor shall: (a) give notice to the Engineer-in-charge, and (b) be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to payment of any such Cost, which shall be included in the Contract Price. After receiving this notice, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine this Cost. If a Taking-Over Certificate has been issued for a part of the Works (other than a Section), the delay damages thereafter for completion of the remainder of the Works shall be reduced. Similarly, the delay damages for the remainder of the Section (if any) in which this part is included shall also be reduced. For any period of delay after the date stated in this Taking-Over Certificate, the proportional reduction in these delay damages shall be calculated as the proportion which the value of the part so certified bears to the value of the Works or Section (as the case may be) as a whole. The Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these proportions. The provisions of this paragraph shall only apply to the rate of delay damages under Sub-Clause 8.9 [Compensation/ Damages for Delay], and shall not affect the maximum amount of these damages.
Taking over if Tests on Completion suffer Interference	**12.3**	If the Contractor is prevented, for more than 14 days, from carrying out the Tests on Completion by a cause for which the Procuring Entity is responsible, the Procuring Entity shall be deemed to have taken over the Works or Section (as the case may be) on the date when the Tests on Completion would otherwise have been completed. The Engineer-in-charge shall then issue a Taking-Over Certificate accordingly, and the Contractor shall carry out the Tests on Completion as soon as practicable, before the expiry date of the Defects Notification Period. The Engineer-in-charge shall require the Tests on Completion to be carried out by giving 14 days' notice and in accordance with the relevant provisions of the Contract. If the Contractor suffers delay and/ or incurs Cost as a result of this delay in carrying out the Tests on Completion, the Contractor shall give notice to the Engineer-in-Charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i. an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of time for Completion], and ii. payment of any such Cost, which shall be included in the Contract Price. After receiving this notice, the Engineer-in-Charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.
Surfaces Requiring Reinstatement	**12.4**	Except as otherwise states in a Taking Over Certificate, a Certificate for a Section or part of the Works shall not be deemed to certify completion of any ground or other surfaces requiring reinstatement.
13. Defect Liability		
Defect Liability Period		13.1 The Contractor warrants that the Facilities or any part thereof shall be free from defects in the design, engineering, materials, and workmanship of the Plant supplied and of the work executed. 13.2 The Defect Liability Period shall be 540 days from the date of Completion of the Facilities (or any part thereof) or 1 year from the date of Operational
		If and to the extent that such work is attributable to any other cause, the Contractor shall be notified promptly by (or on behalf of) the Procuring Entity and Sub-Clause

		Acceptance of the Facilities (or any part thereof), whichever first occurs, unless specified otherwise in the SCC pursuant to GCC Subclause 13.10. If during the Defect Liability Period any defect should be found in the design, engineering, materials, and workmanship of the Plant supplied or of the work executed by the Contractor, the Contractor shall promptly, in consultation and agreement with the Employer regarding appropriate remedying of the defects, and at its cost, repair, replace, or otherwise make good as the Contractor shall determine at its discretion, such defect as well as any damage to the Facilities caused by such defect. The Contractor shall not be responsible for the repair, replacement, or making good of any defect, or of any damage to the Facilities arising out of or resulting from any of the following causes: (a) improper operation or maintenance of the Facilities by the Employer, (b) operation of the Facilities outside specifications provided in the Contract, or (c) normal wear and tear. 13.3 The Contractor's obligations under this GCC Clause 27 shall not apply to: (a) any materials that are supplied by the Employer, if any, as per conditions of the Contract Agreement, are normally consumed in operation, or have a normal life shorter than the Defect Liability Period stated herein; (b) any designs, specifications or other data designed, supplied, or specified by or on behalf of the Employer or any matters for which the Contractor has disclaimed responsibility herein; or (c) any other materials supplied or any other work executed by or on behalf of the Employer, except for the work executed by the Employer under GCC Subclause 13.7. 13.4 The Employer shall give the Contractor a notice stating the nature of any such defect together with all available evidence thereof, promptly following the discovery thereof. The Employer shall afford all reasonable opportunity for the Contractor to inspect any such defect. 13.5 The Employer shall afford the Contractor all necessary access to the Facilities and the Site to enable the Contractor to perform its obligations under this GCC Clause 13. The Contractor may, with the consent of the Employer, remove from the Site any Plant or any part of the Facilities that are defective if the nature of the defect, and/or any damage to the Facilities caused by the defect, is such that repairs cannot be expeditiously carried out at the Site. 13.6 If the repair, replacement or making good is of such a character that it may affect the efficiency of the Facilities or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Facilities shall be made by the Contractor immediately upon completion of such remedial work, whereupon the Contractor shall carry out such tests.

		If such part fails the tests, the Contractor shall carry out further repair, replacement or making good, as the case may be, until that part of the Facilities passes such tests. The tests shall be agreed upon by the Employer and the Contractor. 13.7 If the Contractor fails to commence the work necessary to remedy such defect or any damage to the Facilities caused by such defect within a reasonable time (which shall in no event be considered to be less than 15 days), the Employer may, following notice to the Contractor, proceed to do such work, and the reasonable costs incurred by the Employer in connection therewith shall be paid to the Employer by the Contractor or may be deducted by the Employer from any monies due the Contractor or claimed under the Performance Security. 13.8 If the Facilities or any part thereof cannot be used by reason of such defect and/or making good of such defect, the Defect Liability Period of the Facilities or such part, as the case may be, shall be extended by a period equal to the period during which the Facilities or such part cannot be used by the Employer because of any of the aforesaid reasons. 13.9 Except as provided in GCC Clauses 13 and 32, the Contractor shall be under no liability whatsoever and howsoever arising, and whether under the Contract or at law, in respect of defects in the Facilities or any part thereof, the Plant, design, or engineering, or work executed that appear after Completion of the Facilities or any part thereof, except where such defects are the result of the gross negligence, fraud, criminal, or willful action of the Contractor. 13.10 In addition, any such component of the Facilities and during the period of time as may be specified in the SCC shall be subject to an extended Defect Liability Period. Such obligation of the Contractor shall be in addition to the Defect Liability Period specified under GCC Subclause 13.2.
Completion of Outstanding Work and Remedying Defects.	**13.11**	In order that the Works and Contractor's Documents, and each Section, shall be in the condition required by the Contract (fair wear and tear excepted) by the expiry date of the relevant Defects Notification Period or as soon as practicable thereafter, the Contractor shall: i. complete any work which is outstanding on the date stated in a Taking-Over Certificate, within such reasonable time as is instructed by the Engineer-in-charge, and ii. Execute all work required to remedy Defects or damage, as may be notified by (or on behalf of) the Procuring Entity on or before the expiry date of the Defects Notification Period for the Works. If a Defect appears or damage occurs, the Contractor shall be notified accordingly, by (or on behalf of) the Procuring Entity. The Contractor is required to repair, rectify, the defects, restore the damages at his own cost with in the period indicated in the notice by the Procuring Entity. If the Contractors fails to do so, action as per Sub-Clause 13.7 shall be taken.
		9 [Deviations, Variations and Adjustments] shall apply.
Extension of Defects Notification Period	**13.13**	The Procuring Entity shall be entitled subject to Sub-Clause 2.5 [Procuring Entity's Claims] to an extension of the Defects Notification Period for the Works or a Section if and to the extent that the Works, Section or a major item of work (as the case may be, and after taking over) cannot be used for the purposes for which they are intended by reason of a Defect, deficiency or by reason of damage attributable to the Contractor. However, a Defects Notification Period shall not be

		extended by more than two years. If delivery and/ or erection of Plant and/ or Materials was suspended under Sub-Clause 8.10 [Suspension of Work] or Sub-Clause 17.1 [Contractor's Entitlement to Suspend Work], the Contractor's obligations under this Sub-Clause shall not apply to any Defects or damage occurring more than two years after the Defects Notification Period for the Plant and/ or Materials would otherwise have expired.
Contractor liable for Damages done and for Imperfections	**13.14**	If the Contractor or his personnel shall break, deface, injure or destroy any part of a building or any structure in which they may be working, or any building, road, fence, enclosure, water pipe, power/ telecom cables, drains, electric or telephone post or wires, trees, etc. or cultivated ground contagious to the Site where the Works or any part of it 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 or imperfection 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, procedures 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 employing other workman/ agency 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 Performance Security or the proceeds of sale thereof or a sufficient portion thereof.
Failure to remedy the defect	**13.15**	If the Contractor fails to remedy any Defect, deficiency or damage within a reasonable time, a date may be fixed by (or on behalf of) the Procuring Entity, on or by which the Defect, deficiency or damage is to be remedied. The Contractor shall be given reasonable notice of this date. If the Contractor fails to remedy the Defect or damage by this notified date and this remedial work was to be executed at the cost of the Contractor under Sub-Clause 13.3 [Cost of Remedying Defects], the Procuring Entity may (at his option): i. carry out the work himself or by others, in a reasonable manner and at the Contractor's cost, but the Contractor shall have no responsibility for this work; and the Contractor shall subject to Sub-Clause 2.5 [Procuring Entity's Claims] pay to the Procuring Entity the costs reasonably incurred by the Procuring Entity in remedying the Defect or damage; ii. require the Engineer-in-charge to agree or determine a reasonable reduction in the Contract Price in accordance with Sub-Clause 3.5 [Determinations]; or iii. If the Defect or damage deprives the Procuring Entity of substantially the whole benefit of the Works or any major part of the Works, terminate the Contract as a whole, or in respect of such major part which cannot be put to the intended use. Without prejudice to any other rights, under the Contract or otherwise, the Procuring Entity shall then be entitled to recover all sums paid for the Works or for such part (as the case may be), plus financing Costs and the Cost of dismantling the same, clearing the Site and returning Plant and Materials to the Contractor.
Removal of Defective Work	**13.16**	If the Defect or damage cannot be remedied expeditiously on the Site and the Procuring Entity gives consent, the Contractor may remove from the Site for the purposes of repair such items of Plant as are Defective or damaged. This consent may require the Contractor to increase the amount of the Performance Security by the full replacement Cost of these items, or to provide other appropriate security.
Further Tests	**13.17**	If the work of remedying of any Defect or damage may affect the performance of the Works, the Engineer-in-charge may require the repetition of any of the tests described in the Contract. The requirement shall be made by notice within 28 Days after the Defect or damage is remedied.

		These tests shall be carried out in accordance with the terms applicable to the previous tests, except that they shall be carried out at the risk and cost of the Party liable, under Sub-Clause 13.3 [Cost of Remedying Defects], for the cost of the remedial work.
Contractor / Third Party Quality Inspection Agency to Search for the Cause of the Defect.	**13.918**	The Contractor or third party quality inspection agency shall, if required by the Engineer-in-charge, search for the cause of any Defect, under the direction of the Engineer-in-charge. Unless the Defect is to be remedied at the cost of the Contractor under Sub-Clause 13.3 [Cost of Remedying Defects], the cost of the search shall be agreed or determined by the Engineer-in-charge in accordance with Sub-Clause 3.5 [Determinations] and shall be included in the Contract Price or of the third party quality inspection agency.
Performance Certificate	**13.19**	Performance of the Contractor's obligations shall not be considered to have been completed until the Engineer-in-charge has issued the Performance Certificate to the Contractor, stating the date on which the Contractor completed his obligations under the Contract. The Engineer-in-charge shall issue the Performance Certificate within 28 Days after the latest of the expiry dates of the Defects Liability Periods, or as soon thereafter as the Contractor has supplied all the Contractor's Documents and completed and tested all the Works, including remedying any Defects. A copy of the Performance Certificate shall be issued to the Procuring Entity. Only the Performance Certificate shall be deemed to constitute acceptance of the Works.
Substantial Completion of Parts	**13.20**	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-in-charge may issue a Taking-Over Certificate in respect of that part of the Permanent Works before completion of 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 Defect Liability Period.
Unfulfilled Obligations	**13.21**	After the Performance Certificate has been issued, each Party shall remain liable for the fulfilment of any obligation which remains unperformed at that time. For the purposes of determining the nature and extent of unperformed obligations, the Contract shall be deemed to remain in force.
Right to Access	**13.22**	Until the Performance Certificate has been issued, the Contractor shall have such right of access to the Works as is reasonably required in order to comply with this Sub-Clause, except as may be inconsistent with the Procuring Entity's reasonable security restrictions.
Clearance of Site	**13.23**	Upon receiving the Performance Certificate, the Contractor shall remove any remaining Contractor's Equipment, surplus material, wreckage, rubbish and Temporary Works from the Site. If all these items have not been removed within 28 days after receipt by the Contractor of the Performance Certificate, the Procuring Entity may sell or otherwise dispose of any remaining items. The Procuring Entity shall be entitled to be paid the costs incurred in connection with, or attributable to, such sale or disposal and restoring the Site. Any balance of the moneys from the sale shall be paid to the Contractor. If these moneys are less than the Procuring Entity's costs, the Contractor shall pay the outstanding balance to the Procuring Entity.
14. Measurement and Evaluation. ***(In case of Lump Sum Contract measurement of only additions and alterations shall be taken)***		

Measurement of Work Done	**14.1**	Whenever the Engineer-in-charge requires any part of the Works to be measured/ re-measured, reasonable notice shall be given to the Contractor's Representative, who shall: i. promptly either attend or send another qualified representative to assist the Engineer-in-charge in taking/ verifying the measurement, and ii. Supply any particulars requested by the Engineer-in-charge for his satisfaction of the measurements. If the Contractor fails to attend or send a representative, the measurement made by (or on behalf) of the Engineer-in-charge shall be accepted as accurate.
Method of measurement.	**14.2.1**	The measurements (as per IS 1200) of the executed and acceptable work shall be recorded once in a month by the representative of the Engineer–in-Charge and the Contractor or his representative jointly and shall be signed by the Contractor in acceptance. The Engineer–in-Charge shall, except as otherwise provided, shall check, ascertain and determine measurement and the value of the work done in accordance with the Contract. The Procuring Entity reserves to itself the right to prescribe a scale of check measurements of work, in general, or a specific scale for specific works or by other special orders (about which the decision of the Procuring Entity shall be final). Checking of measurement by a superior officer shall supersede the measurements taken by the subordinate officers and the former will become the basis of the payment. Any excess payments detected, as a result of such check measurement or otherwise at any stage up to the date of completion and the Defect Liability Period specified elsewhere in this Contract, shall be recoverable from the Contractor as any other dues payable to the Procuring Entity. The Contractor shall, without extra charge, provided all necessary assistance with labour and equipment necessary for measurements and recording levels. 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.
	14.2.2	All measurement of all items having financial value shall be recorded in Measurement Book or MS Excel file and printed out in two copies. The original shall be treated as the Measurement book. Such files in original shall be mailed to the Engineer-in-Charge and shall be saved with a dedicated password. Other data like initial field levels or survey field books or findings of the geo tech investigations shall be similarly recorded and protected so that a complete record is obtained of all works performed under the Contract.
	14.2.3	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/ Organisation 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 seven days 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 have been accepted by the Contractor. Except where any general or detailed description of the work expressly shows to the contrary, measurements shall be taken of the net actual quantities in accordance with the procedure set forth in the Bill of Quantities and IS 1200 notwithstanding any general or local practice. The Contractor shall give not less than seven Day's notice to the Engineer-in-Charge or his authorized representative in charge of the Works 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 measurements and shall not cover and place beyond reach of measurement any work without consent in writing of the Engineer-in-Charge or his authorized representative in charge of the Works 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, for the due measurement or in default thereof no payment or allowance shall be made for such works or the materials with which the same was executed. The covering shall then be restored by the Contractor at his cost. Engineer-in-Charge or his authorized representative may cause either themselves or through another officer of the Department/ Organisation 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 sheets/ 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 other measurement, Defects noticed till completion of the Defects liability period.
Omissions	**14.3**	Whenever the omission of any work forms part (or all) of a Variation, the value of which has not been agreed, if: i. the Contractor will incur (or has incurred) Cost which, if the work had not been omitted, would have been deemed to be covered by a sum forming part of the Accepted Contract Amount; ii. the omission of the work will result (or has resulted) in this sum not forming part of the Contract Price; and iii. this Cost is not deemed to be included in the evaluation of any substituted work; then the Contractor shall give notice to the Engineer-in-charge accordingly, with supporting particulars. Upon receiving this notice, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine this Cost, which shall be included in the Contract Price.
15. Contract Price, Payment and Lien		
Contract price	**15.1**	Unless otherwise stated in the Particular Conditions: i. the Contract Price shall be agreed or determined and be subject to adjustments in accordance with the Contract; ii. the Contractor shall pay all taxes, duties and fees required to be paid by him under the Contract, and the Contract Price shall not be adjusted for any of these Costs except as stated in Sub-Clause 15.21 [Adjustments for Changes in Legislation] or Price adjustment; iii. any quantities which may be set out in the Bill of Quantities or other Schedule are estimated quantities and are not to be taken as the actual and correct quantities: (a) of the Works which the Contractor is required to execute, or (b) for the purposes of Sub-Clause 11 [Measurement and Evaluation]; and iv. the Contractor shall submit to the Engineer-in-charge, within 28 Days after the Commencement Date, a proposed breakdown of each lump sum price in the Schedules. The Engineer-in-charge may take account of the breakdown when preparing Payment Certificates, but shall not be bound by it.
Lump sum provisions in	**15.2**	When the estimate includes lump sum provisions primarily in respect of parts of work/ items whose specifications and costs are not known at the time of framing

Estimate/ Contract		the Estimate, and if a bid is to be invited on such an estimate, such lump sum shall be excluded from the bid. Subsequently, when the specifications and costs of such items are known, their execution, if to be completed concurrently with the Contract, shall either be done as a variation item or on market rates (without bid premium) of the Contract. Such variation should be approved by the competent authority and then the Contractor shall be entitled to payment in respect of such items of work, or separate bids shall be invited for the work to be executed concurrently with the present Contract.
Schedule of Payments *(in case of Lump Sum Contract payments shall be linked to various stages of completion of Works given in the Activity Schedule)*	**15.3**	The schedule of payments shall be as included in the Contract. If the Contract does not include a schedule of payments, the Contractor shall submit non-binding estimates of the payments which he expects to become due during each quarterly period. The first estimate shall be submitted within 28 Days after the Commencement Date. Revised estimates shall be submitted at quarterly intervals, until the Taking-Over Certificate has been issued for the Works. The percentage quoted in the Bid and accepted in the Contract will be deducted/added from/to the gross amount of the bill.
Application for Interim Payment Certificates (Running Account Bills)	**15.4**	The Contractor shall submit a Statement in required number of copies to the Engineer-in-Charge after the end of each month, in a form approved by the Engineer-in-Charge, showing in detail the amounts to which the Contractor considers himself to be entitled on the basis of measurement (or Activity Schedule in case of Lump sum Contract) and advance payment, secured advance, deductions, etc. as applicable, together with supporting documents which shall include the report on the progress during this month in accordance with Sub-Clause4.20 [Progress Reports].
Issue of Interim Payment Certificates	**15.5**	No amount will be certified or paid until the Procuring Entity has received and accepted the Performance Security. Thereafter, the Engineer-in-charge shall, within 28 Days after receiving a Statement and supporting documents, deliver to the Procuring Entity and to the Contractor an Interim Payment Certificate which shall state the amount which the Engineer-in-charge fairly determines to be due, with all supporting particulars for any reduction or withholding made by the Engineer-in-charge on the Statement, if any. However, prior to issuing the Taking Over Certificate for the Works, the Engineer-in-charge shall not be bound to issue an Interim Payment Certificate in an amount which would (after retention and other deductions) be less than the minimum amount of Interim Payment Certificate (if any) stated in the Contract Data. In this event, the Engineer-in-charge shall give notice to the Contractor accordingly. An Interim Payment Certificate shall not be withheld for any other reason, although: i. if anything supplied or work done by the Contractor is not in accordance with the Contract, the cost of rectification or replacement may be withheld until rectification or replacement has been completed; and/or ii. if the Contractor was or is failing to perform any work or obligation in accordance with the Contract, and had been so notified by the Engineer-in-charge, the value of this work or obligation may be withheld until the work or obligation has been performed. The Engineer-in-charge may in any Payment Certificate make any correction or modification that should properly be made to any previous Payment Certificate. A Payment Certificate shall not be deemed to indicate the Engineer-in-charge's acceptance, approval, consent or satisfaction.

Payment of an Interim Payment Certificate	**15.6.1**	A bill shall be submitted by the Contractor each month on or before the date fixed by the Engineer-in-charge for all work executed in the previous month and the Engineer-in-charge shall take or cause to be taken or check the requisite measurement for the purpose of having the same verified and the claim, as far as admissible, authorized or paid, if possible, before the expiry of thirty days from the presentation for the bill. If the contractor does not submit the bill within the time fixed, as aforesaid, the Engineer-in-charge may depute a subordinate to measure up the said work in the presence of the Contractor, whose signature in the Measurement Book or sheet will be sufficient warrant and the Engineer-in-charge may prepare a bill from such Measurement Book, which shall be binding on the Contractor in all respects.
Payment at Part Rates	**15.6.2**	The rates for several items of works may be paid in part rates provisionally in running bills in proportion to the quantum of items executed as per specifications at the discretion of the Engineer-in-charge. The deferred payment, will however, be released after the successful completion of the item of work. In case of item rates, if the rate quoted for certain items is very high in comparison to the average/overall bid value over the estimated cost of the work, the payment at running stages shall not be made until an appropriate additional performance security for items for which rates have been quoted high, has been submitted by the Contractor. This security shall be refunded at the final stage of completion.
Payment at Reduced Rates	**15.6.3**	In case certain item of the Works has not been executed as per specifications, design, drawings and the specified durability and the Engineer-in-Charge is not convinced to accept the item of Works at the full rate applicable under the Contract, may accept such item at a reduced rate (in proportion to the designed and executed capability and or the designed and assessed service life of the structure and its components) with a minimum reduction of 25% of the full rate 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 whole Works. Decision of the Engineer-in-Charge to be conveyed in writing in respect of the same will be final and binding on the Contractor.
Recovery of Cost of Water and Electricity consumed by the Contractor	**15.6.4**	The cost of all water connections necessary for the execution of Works, and the cost of water consumed and hire charges of meters and the cost of electricity consumed in connection with the execution of the Works shall be paid by the Contractor except where otherwise specifically provided in the Contract Data.
Recovery of materials issued and hire charges of Machinery and Equipment, etc.	**15.6.5**	Recoveries on account of materials issued to the Contractor by the Procuring Entity, Machinery and Equipment lent on hire, advance payment, secured advance, etc. or on any other account, and dues shall be made from each payment certificate from the Contractor as per conditions of this Contract.
Payment on Intermediate Certificate to be regarded as Advances	**15.7**	All 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.
Application for issue of final	**15.8**	The Contractor shall apply to the Engineer-in-Charge for issue of the Final Completion Certificate at least 45 days in advance of the likely date of full/ satisfactory completion. The Engineer-in-Charge during this period shall review

completion certificate		and finalise the requirements of work to qualify as final completion with respect to the third party quality inspection agency reports, if any. The Final completion certificate shall be issued within 30 days of its becoming due as per notice.
issue of final completion certificate	**15.9**	After the Contractor has rectified all deficiencies pointed out by the Engineer-in-Charge in the final payment documents, and complied to all observations of the Third Party Quality Inspection Agency and the Independent Engineer to the entire satisfaction of the Engineer-in-Charge, the Contractor shall apply to the Engineer-in-Charge releasing the final payment as per final statement and also issue a final payment certificate. The Engineer-in-Charge shall proceed to issue the final payment certificate after reviewing all tests on completion, determinations, as built design and drawings, and other compliances required under the Contract.
Final Statement of payments	**15.10**	Within 28 Days after receiving the Taking Over Certificate for the Works, the Contractor shall submit to the Engineer-in-charge, six copies of a draft final statement with as built drawings (with two soft copies also) and all other supporting documents showing in detail in a form approved by the Engineer-in-charge the value of all work done in accordance with the Contract, and any further sums which the Contractor considers to be due to him under the Contract or otherwise. If the Engineer-in-charge disagrees with or cannot verify any part of the draft final statement, the Contractor shall submit such further information as the Engineer-in-charge may reasonably require within 28 Days from receipt of said draft and shall make such changes in the draft as may be agreed between them. The Contractor shall then prepare and submit to the Engineer-in- charge the final statement as agreed. This agreed statement is referred to in these Conditions as the "Final Statement". However if, following discussions between the Engineer-in- charge and the Contractor and any changes to the draft final statement which are agreed, it becomes evident that a dispute exists, the Engineer-in-charge shall deliver to the Procuring Entity's competent authority (with a copy to the Contractor) an Interim Payment Certificate for the agreed parts of the draft final statement.
Discharge	**15.11**	When submitting the Final Statement, the Contractor shall submit a discharge which confirms that the total of the Final Statement represents full and final settlement of all moneys due to the Contract or under or in connection with the Contract. This discharge may state that it becomes effective when the Contractor has received the Performance Security and the outstanding balance of this total, in which event the discharge shall be effective on such date.
Payment of Final Bill	**15.12**	The final value of the acceptable works done, less payments already received, value of claims raised and paid, value of claims not paid along with Interim Payment Certificates, final statement of price escalation due and paid, etc. shall be submitted by the Contractor along with the 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 issued 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 a period of 90 days, the period being reckoned from the date of receipt of the bill by the Engineer-in-Charge complete with accounts of advances, Materials issued, Machinery & Equipment lent on hire by the Procuring Entity, dismantled Materials, etc.
Recovery of cost of preparation of the bill	**15.13**	In case the Contractor does not submit the bill within the time fixed, the Engineer-in-charge may prepare the bill as per provision of Sub-Clause 15.6.1 [Payment of an Interim Payment Certificate] but a deduction @ 0.5 % of the amount of such a bill shall be made and credited to the general revenue account of the Department/

		Organisation on account of preparation of the bill. The Contractor shall submit all bills on the printed forms, to be had on application, at the office of the Engineer- in- charge and the charges in the bills shall always be entered at the rates specified in the Contract or in the case of any extra work ordered in pursuance of these conditions, and not mentioned or provided for in the Contract, at the rates approved for such work.
Payment of Contractor's Bills to Banks	**15.14**	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 (i) the account number with name and address of branch of the Bank, (ii) an authorization in the form of a legally valid document such as a power of attorney conferring authority on the Bank to receive payments, and (iii) his own acceptance of the correctness of the amount made out as being due to him by Procuring Entity or his signature on the bill or other claim preferred against Procuring Entity before settlement by the Engineer-in-Charge of the account or claim by payment to the Bank. While the receipt given by such copy of Banks statement shall constitute a full and sufficient discharge for the payment, the Contractor shall also acknowledge with a receipt. Wherever possible the Contractor shall 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 Procuring Entity/ Governor of Rajasthan.
Advance Payments	**15.15**	If provided in the SCC, the Procuring Entity shall make an advance payment on simple interest (rate as specified in SCC) as an mobilization for the Works, when the Contractor submits a Bank Guarantee of an equal amount from a Scheduled Bank in India. The total advance payment, the number and timing of instalment (if more than one), and the applicable currencies and proportions, shall be as stated in the Contract Data. Unless and until the Procuring Entity receives this Bank Guarantee and got confirmed from the issuing Bank, or if the provision of advance payment is not stated in the SCC, this Sub-Clause shall not apply. Unless stated otherwise in the Contract Data, the advance payment shall be repaid through percentage deductions from the interim payments determined by the Engineer-in-charge in accordance with Sub-Clause 15.5 [Issue of Interim Payment Certificates], as follows i. deductions shall commence in the next interim Payment Certificate following that in which the total of all certified interim payments (excluding the advance payment and deductions and repayments of retention) exceeds 30 percent of the Accepted Contract Amount less Provisional Sums; and ii. deductions shall be made at the amortisation rate stated in the Contract Data of the amount of each Interim Payment Certificate (excluding the advance payment and deductions for its repayments as well as deductions for retention money) in the currencies and proportions of the advance payment until such time as the advance payment has been repaid; provided that the advance payment shall be completely repaid prior to the time when 90 percent of the Accepted Contract Amount less Provisional Sums has been certified for payment. If the advance payment has not been repaid prior to the issue of the Taking-Over Certificate for the Works or prior to termination under Sub-Clause 16.1 [Termination by Procuring Entity], Sub-Clause 17.2 [Termination by Contractor] or Sub-Clause 19 [Force Majeure] (as the case may be), the whole of the balance then outstanding shall immediately become due to the Procuring Entity.
Secured Advance on Non-Perishable Materials	**15.16**	The Contractor, on signing an indenture in the form to be specified by the Engineer-in-Charge, may be paid during the progress of the execution of the work, up to 75% of the assessed value of any Materials which have been actually brought at the Site and which, in the opinion of the Engineer-in-charge, are non-

(Not applicable in case of Lump Sum Contract)		perishable, non-fragile and non-combustible and will be consumed in the Works within next three months in accordance with the construction programme and the Contract provided that they are adequately stored and/ or protected against damage by weather or other causes but which have not, at the time of granting 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 of the Sub-Clauses of this Contract.
Ensuring Payment and Amenities to Workers if Contractor fails to pay	**15.17**	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, any applicable Labour Laws, the Procuring Entity 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 Laws 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 the Contractor, the Procuring Entity shall 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 Procuring Entity under sub-section (2) of Section 20, and sub-section (4) of Section 21, of the Contract Labour (Regulation and Abolition) Act, 1970, Government shall be at liberty to recover such amount or any part thereof by deducting it from the Performance Security or from any sum due by the Procuring Entity to the Contractor whether under this Contract or otherwise. The Procuring Entity 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 Procuring Entity full security for all costs for which the Procuring Entity might become liable in contesting such claim.
Withholding and lien in respect of sums due from Contractor	**15.18**	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 Performance 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 Performance Security furnished, if any and also have a lien over the same pending finalization or adjudication of any such claim. In the event of the security being insufficient to cover the claimed amount or amounts or if no security has been taken from the Contractor, the Engineer-in-Charge or the 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 or the Government or any Contracting person through the Engineer-in-Charge pending finalization of adjudication of any such claim. It is an agreed term of the Contract that the sum of money or moneys so withheld or retained under the lien referred to above by the Engineer-in-Charge or Government will be kept withheld or retained as such by the Engineer-in-Charge or Government till the claim arising out of or under the Contract is determined by the arbitrator (if the Contract is governed by the arbitration Sub-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 Sub-Clause, where the Contractor is a partnership firm or a limited company, the Engineer-in-Charge or the Government 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. The Procuring Entity 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 within two years 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 the Procuring Entity to recover the same from him in the manner prescribed 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 the Procuring Entity to the Contractor, without any interest thereon whatsoever.
Lien in respect of claims in other Contracts	**15.19**	Any sum of money due and payable to the Contractor (including the Performance Security returnable to him) under the Contract may be withheld or retained by way of lien by the Engineer-in-Charge or the Government or any other Contracting person or persons through Engineer-in-charge against any claim of the Engineer-in-Charge or the Government or such 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 Government or with such person or persons. It is an agreed term of the Contract that the sum of money so withheld or retained under this Sub-Clause by the Engineer-in- Charge or the Government will be kept withheld or retained as such by the Engineer-in-Charge or the Government till his claim arising out of the same Contract or any other Contract is either mutually settled or determined by the arbitration Sub-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 Sub-Clause and duly notified as such to the Contractor.
Levy or Taxes payable by Contractor	**15.20**	i. VAT/ Sales Tax/ GST, service tax or any other taxes and duties on Materials, works or services 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. The liability, if any, on account of quarry fees, royalties, octroi and other taxes and duties in respect of materials actually consumed on the Works, shall be borne by the Contractor. 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. iv. In respect of goods and Materials procured by the Contractor, for use in Works under the Contract, VAT will be paid by the Contractor himself but in respect of such goods manufactured and supplied by the Contractor and Works executed under the contract, the responsibility of payment of VAT shall be that of the Procuring Entity.

Adjustments for changes in Legislation	**15.21**	i All the bid rates shall be inclusive of all taxes and levies payable under respective statutes, However if any further tax or levy is imposed by Statute, after the Base Date and the Contractor thereupon necessarily and properly pays such taxes/ levies the Contractor shall be reimbursed the amount so paid, provided such payments, if it any, is not, in the opinion of the Procuring Entity (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 authorized representative of the Procuring Entity 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, 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. This Sub-Clause shall not be applicable if the effect of changes in legislation has been included in price variation formulae in Clause 10 [Price Variation].
Pre Check and Post Check of Bills	**15.22**	The Government/ Procuring Entity shall have a right to provide a system of pre check of Contractor's bills by a specified organization and payment by an Accounts Organisation as the Government/ Procuring Entity may in its absolute discretion decide. Any overpayments detected as a result of such pre check or post check of Contractor's bills can be recovered from the Contractor's bills and the Contractor will refund such excess payments.
16. Termination of Contract by Procuring Entity		
Termination by Procuring Entity	**16.1**	16.1 <u>Termination for Employer's Convenience</u> 16.1.1 The Employer may at any time terminate the Contract for any reason by giving the Contractor a notice of termination that refers to this GCC Subclause 16.1. 16.1.2 Upon receipt of the notice of termination under GCC Subclause 16.1.1, the Contractor shall, either immediately or upon the date specified in the notice of termination, (a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition; (b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) (ii) below; (c) remove all Contractor's Equipment from the Site, repatriate the Contractor's and its Subcontractors' personnel from the Site, remove from the Site any wreckage, rubbish and debris of any kind, and leave the whole of the Site in a clean and safe condition; and (d) subject to the payment specified in GCC Subclause 16.1.3, (i) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination; (ii) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant as of the date of

		termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors; and (iii) deliver to the Employer all non-proprietary drawings, specifications and other documents prepared by the Contractor or its Subcontractors as at the date of termination in connection with the Facilities. 16.1.3 In the event of termination of the Contract under GCC Subclause 16.1.1, the Employer shall pay to the Contractor the following amounts: (a) the Contract Price, properly attributable to the parts of the Facilities executed by the Contractor as of the date of termination; (b) the costs reasonably incurred by the Contractor in the removal of the Contractor's Equipment from the Site and in the repatriation of the Contractor's and its Subcontractors' personnel; (c) any amounts to be paid by the Contractor to its Subcontractors in connection with the termination of any subcontracts, including any cancellation charges; (d) costs incurred by the Contractor in protecting the Facilities and leaving the Site in a clean and safe condition pursuant to paragraph (a) of GCC Subclause 16.1.2; and (e) the cost of satisfying all other obligations, commitments and claims that the Contractor may in good faith have undertaken with third parties in connection with the Contract and that are not covered by paragraphs (a) through (d) above. Subject to the other provisions contained in this Sub-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 a notice of reasonable period in writing absolutely determine the Contract in any of the following cases: i If 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 un-workmanlike manner, or by workers who do not understand the instructions of the Engineer-in-Charge, or do not execute the work as per specifications or in contravention of the advice of the third party quality inspections agency about the quality of works, if any, shall omit to comply with the requirement of such notice for a period of fifteen Days thereof. ii If the Contractor being a company shall pass a resolution or the Court shall make an order that the company shall be wound up or if a receiver or a manager on behalf of a creditor shall be appointed or if circumstances shall arise which entitle the Court or the 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 Works for a continuous period of 30 days, or has failed to proceed with the Works with due diligence so that, in the reasoned opinion of the Engineer-in-Charge (which shall be final and binding), he will be unable to secure completion of the Works by the stipulated date of completion and

		continues to do so after a notice in writing of fifteen Days from the Engineer-in-Charge. iv If the Contractor fails to complete the Works within the stipulated time or spans of the Works with individual date of completion, if any stipulated, on or before such date(s) of completion and or fails to achieve two continuous mile stones, does not complete them within the period specified in a notice given in writing on 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 fifteen Days after a notice in writing is given to him on that behalf by the Engineer-in-charge. vi If the Contractor sublets the Works or a part of Works without specific permission of the Procuring Entity/ Engineer-in-charge. vii If the Contractor has not been commenced the Works by the Commencement Date or within 1/8th of the stipulated time for completion subject to a maximum of 45 Days, whichever is earlier. When the Contractor has made himself liable for action under any of the cases aforesaid, the Engineer-in-Charge on behalf of the Procuring Entity shall have the powers: (a) To determine or rescind the Contract as aforesaid (of which a 28 days 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 Bid Security and Performance Security under the Contract shall be liable to be forfeited and shall be absolutely at the disposal of the Procuring Entity. (b) To employ labour paid by the Procuring Entity and to supply materials to carry out the Works or any part of the Works, debiting the Contractor with the cost of the labour and the price of the materials (of the amount of which cost and price certified by the Engineer-in-charge shall be final and conclusive against the Contractor) and crediting him with the value of the work done in all respects in the same manner and at the same rates, as if it has been carried out by the Contractor under the terms of this Contract. The certificate of the Engineer-in-Charge, as to the value of the work done, shall be final and conclusive evidence against the Contractor provided always that action under the sub Sub-Clause shall only be taken after giving notice in writing to the Contractor. Provided also that if the expenses incurred by the Procuring Entity are less than the amount payable to the Contractor at his agreement rates, the difference shall not be paid to the Contractor. (c) After giving notice specifying the date and time to the Contractor to measure up the acceptable (executed as per design, drawings and specifications) work of the Contractor at Site and to take such part thereof, as shall be unacceptable out of his hands and to give it to another contractor to complete, in which case any expenses which may be incurred in excess of the sum which would have been paid to the original Contractor, if the whole work had been executed by him (of the amount of which excess, the certificate in writing of the Engineer-in-charge shall be final and conclusive) shall be borne and paid by the original Contractor and may be deducted from any money due to him by the Procuring Entity under this Contract or any other account, whatsoever, or from his Bid Security, Performance Security or the Enlistment Security or the proceeds of sale thereof, or a sufficient part thereof as the case may be. In the event of any one or more of the above courses being adopted by the Engineer-in-charge the contractor shall have no claim to compensation for any loss sustained by him by reason 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 Works or the performance of the Contract. In case action is taken under any of the aforesaid provisions, 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 value payable in respect thereof and he shall only be entitled to be paid the value so certified.
Contractor liable to pay compensation even if action not taken under Sub-Clause 16.1 above	**16.2**	i In any case in which the powers conferred upon the Engineer- in-Charge by Sub-Clause 16.1 [Termination by Procuring Entity] shall have become exercisable and the same are not exercised, the non-exercise of such powers 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. ii In the event of the Engineer-in-Charge putting in force all or any of the powers vested in him under the preceding Sub-Clause 16.1, he may, if he so desires, after giving a notice in writing to the Contractor, take possession of all or any tools, plants, materials and stores, in or upon the Works or the Site, thereof or belonging to the Contractor or procured by him and intended to be used for execution of the Works 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 conclusive), otherwise the Engineer-in-Charge may, by notice in writing to the Contractor or his authorized agent, require him to remove such tools, plants, materials or stores from the premises (within a time to be specified in such notice), and 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.
Valuation at the date of termination:	**16.3**	As soon as practicable after a notice of termination under Sub-Clause 16.1 has taken effect, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the value of the Works, Goods and Contractor's Documents, and any other sums due to the Contractor for work executed in accordance with the Contract.
Payment after Termination	**16.4**	After a notice of termination under Sub-Clause 16.1 has taken effect, the Procuring Entity may: i proceed in accordance with Sub-Clause 3.5 [Procuring Entity's Claims], ii withhold further payments to the Contractor until the Costs of execution, completion and remedying of any Defects, damages for delay in completion (if any), and all other Costs incurred by the Procuring Entity, have been established, and iii recover from the Contractor any losses and damages incurred by the Procuring Entity and any extra Costs of completing the Works, after allowing for any sum due to the Contractor under Sub-Clause 16.3. After recovering any such losses, damages and extra Costs, the Procuring Entity shall pay balance to the Contractor, if any.
Procuring Entity's Entitlement to Termination for Convenience	**16.5**	If, at any time after the commencement of the Works, the Government/ Procuring Entity shall, for any reason, whatsoever, not require the whole work, thereof, as specified in the Contract, to be carried out, the Engineer-in-charge shall give notice, in writing, of the fact to the Contractor, who shall have no claim to any payment or compensation, 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 full amount of the Works not having been carried out. Neither shall he have any claim for compensation by reason of alterations having been made in the original specifications, drawings and design and instructions, which shall involve any curtailment of the Works, as originally contemplated. Provided, that the contractor shall be paid the charges for the cartage only, of materials actually brought to the Site of the Works by him for bonafide use and rendered surplus as a result of the abandonment or curtailment of the Works or any portion thereof, and taken them back by the Contractor provided, however, that the Engineer-in-charge shall have, in all such cases, the option of taking over all or any such materials at their purchase price or at local market rates whichever may be less.
Corrupt, Fraudulent, C**ollusive or Coercive Practices**	**16.6**	If the Procuring Entity determines that the Contractor, his Sub-Contractors or any of their personnel has breached the Code of Integrity prescribed in the Act, the Rules, or the Instructions to Bidders [Section I of the Bidding Document] or has engaged in corrupt, fraudulent, collusive or coercive practices, in competing for or in executing the Contract, then the Procuring Entity may, after giving 14 Days notice to the Contractor: i terminate the Contract and expel him from the Site, ii forfeit or encash performance security and any other security or bond relating to this Contract, iii recover the payments made under the Contract along with interest thereon at bank rate, iv recover compensation for loss incurred due to termination of the Contract including excess expenditure, if any incurred in getting the remaining work executed from other agency under Sub-Clause 16.1. For the purposes of this Sub-Clause: i "corrupt practice" means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence the action of a public official in the procurement process or in the Contract execution; ii "fraudulent practice" means a misrepresentation or omission of facts in order to influence a procurement process or the execution of the Contract; iii "collusive practice" means a scheme of arrangement between two or more bidders, with or without the knowledge of the Procuring Entity, designed to establish bid prices at artificial, non-competitive levels; iv "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the procurement process or affect the execution of a Contract. Should any employee of the Contractor be determined to have engaged in corrupt, fraudulent or coercive practice during the execution of the Works then that employee shall be removed in accordance with Sub-Clause 6.11 [Contractor's Personnel].
Termination of Contract on death of Contractor	**16.7**	Without prejudice to any of the rights or remedies under this Contract, if the Contractor dies, the Procuring Entity 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 in a position to complete the work as Contracted or are not going to be in this profession in future.
17. Suspension of Works and Termination by the Contractor		
Contractor's Entitlement to Suspend Work	**17.1**	17.1 <u>Termination for Contractor's Default</u> 17.1.1 The Employer, without prejudice to any other rights or remedies it may possess, may terminate the Contract forthwith in the following circumstances

		by giving a notice of termination and its reasons therefor to the Contractor, referring to this GCC Subclause 17.1: (a) if the Contractor becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, if the Contractor is a corporation, a resolution is passed or order is made for its winding up, other than a voluntary liquidation for the purposes of amalgamation or reconstruction, a receiver is appointed over any part of its undertaking or assets, or if the Contractor takes or suffers any other analogous action in consequence of debt; (b) if the Contractor assigns or transfers the Contract or any right or interest therein in violation of the provision of GCC Clause 40; and (c) if the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices, in competing for or in executing the Contract. 17.2.2 If the Contractor (a) has abandoned or repudiated the Contract; (b) has without valid reason failed to commence work on the Facilities promptly or has suspended, other than pursuant to GCC Subclause 16, the progress of Contract performance for more than 28 days after receiving a written instruction from the Employer to proceed; (c) persistently fails to execute the Contract in accordance with the Contract or persistently neglects to carry out its obligations under the Contract without just cause; (d) refuses or is unable to provide sufficient materials, services or labor to execute and complete the Facilities in the manner, specified in the Work program furnished by the contractor at the time of agreement ang at rates of progress that give reasonable assurance to the Employer that the Contractor can attain Completion of the Facilities by the Time for Completion as extended; then the Employer may, without prejudice to any other rights it may possess under the Contract, give a notice to the Contractor, stating the nature of the default and requiring the Contractor to remedy the same. If the Contractor fails to remedy or to take steps to remedy the same within 14 days of its receipt of such notice, then the Employer may terminate the Contract forthwith by giving a notice of termination to the Contractor that refers to this GCC Subclause 17.1. 17.2.3 Upon receipt of the notice of termination under GCC Subclauses 17.1.1 or 17.1.2, the Contractor shall, either immediately or upon such date as is specified in the notice of termination, (a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition;

		(b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) below; (c) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination; (d) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant as of the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors; and (e) deliver to the Employer all drawings, specifications and other documents prepared by the Contractor or its Subcontractors as of the date of termination in connection with the Facilities. 17.1.4 The Employer may enter upon the Site, expel the Contractor, and complete the Facilities itself or by employing any third party. The Employer may, to the exclusion of any right of the Contractor over the same, take over and use with the payment of a fair rental rate to the Contractor, with all the maintenance costs to the account of the Employer and with an indemnification by the Employer for all liability including damage or injury to persons arising out of the Employer's use of such equipment, any Contractor's Equipment owned by the Contractor and on the Site in connection with the Facilities for such reasonable period as the Employer considers expedient for the supply and installation of the Facilities. Upon completion of the Facilities or at such earlier date as the Employer thinks appropriate, the Employer shall give notice to the Contractor that such Contractor's Equipment will be returned to the Contractor at or near the Site and shall return such Contractor's Equipment to the Contractor in accordance with such notice. The Contractor shall thereafter without delay and at its cost remove or arrange removal of the same from the Site. 17.1.5 Subject to GCC Subclause 17.1.6, the Contractor shall be entitled to be paid the Contract Price attributable to the Facilities executed as of the date of termination, the value of any unused or partially used Plant on the Site, and the costs, if any, incurred in protecting the Facilities and in leaving the Site in a clean and safe condition pursuant to paragraph (a) of GCC Subclause 17.1.3. Any sums due the Employer from the Contractor accruing prior to the date of termination shall be deducted from the amount to be paid to the Contractor under this Contract. 17.1.6 If the Employer completes the Facilities, the cost of completing the Facilities by the Employer shall be determined. If the sum that the Contractor is entitled to be paid, pursuant to GCC Subclause 17.1.5, plus the reasonable costs incurred by the Employer in completing the Facilities, exceeds the Contract Price, the Contractor shall be liable for such excess. If such excess is greater than the sums due the Contractor under GCC Subclause 17.1.5, the Contractor shall pay the balance to the Employer, and if such excess is less than the sums due the Contractor under GCC Subclause 17.1.5, the Employer shall pay the balance to the Contractor.

		The Employer and the Contractor shall agree, in writing, on the computation described above and the manner in which any sums shall be paid. 17.2 Termination by Contractor 17.2.1 If (a) the Employer has failed to pay the Contractor any sum due under the Contract within the specified period, has failed to approve any invoice or supporting documents without just cause pursuant to the Appendix (Terms and Procedures of Payment) to the Contract Agreement, or commits a substantial breach of the Contract, the Contractor may give a notice to the Employer that requires payment of such sum, with interest thereon as stipulated in GCC Subclause 15.6, requires approval of such invoice or supporting documents, or specifies the breach and requires the Employer to remedy the same, as the case may be. If the Employer fails to pay such sum together with such interest, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, fails to remedy the breach or take steps to remedy the breach within 14 days after receipt of the Contractor's notice; or (b) the Contractor is unable to carry out any of its obligations under the Contract for any reason attributable to the Employer, including but not limited to the Employer's failure to provide possession of or access to the Site or other areas or failure to obtain any governmental permit necessary for the execution and/or completion of the Facilities; then the Contractor may give a notice to the Employer thereof, and if the Employer has failed to pay the outstanding sum, to approve the invoice or supporting documents, to give its reasons for withholding such approval, or to remedy the breach within 28 days of such notice, or if the Contractor is still unable to carry out any of its obligations under the Contract for any reason attributable to the Employer within 28 days of the said notice, the Contractor may by a further notice to the Employer referring to this GCC Subclause 17.2.1, forthwith terminate the Contract. 17.2.2 The Contractor may terminate the Contract forthwith by giving a notice to the Employer to that effect, referring to this GCC Subclause 17.2.2, if the Employer becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, being a corporation, if a resolution is passed or order is made for its winding up (other than a voluntary liquidation for the purposes of amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if the Employer takes or suffers any other analogous action in consequence of debt. 17.2.3 If the Contract is terminated under GCC Subclauses 17.2.1 or 17.2.2, then the Contractor shall immediately (a) cease all further work, except for such work as may be necessary for the purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition; (b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) (ii); (c) remove all Contractor's Equipment from the Site and repatriate the Contractor's and its Subcontractors' personnel from the Site; and

		(d) subject to the payment specified in GCC Subclause 17.2.4, (i) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination; (ii) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant as of the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors; and (iii) deliver to the Employer all drawings, specifications and other documents prepared by the Contractor or its Subcontractors as of the date of termination in connection with the Facilities. 17.2.4 If the Contract is terminated under GCC Subclauses 17.2.1 or 17.2.2, the Employer shall pay to the Contractor all payments specified in GCC Subclause 16, and reasonable compensation for all loss, except for loss of profit, or damage sustained by the Contractor arising out of, in connection with or in consequence of such termination. 17.2.5 Termination by the Contractor pursuant to this GCC Subclause 17.2 is without prejudice to any other rights or remedies of the Contractor that may be exercised in lieu of or in addition to rights conferred by GCC Subclause 17.2. 17.3 In this GCC Clause 42, the expression "Facilities executed" shall include all work executed, Installation Services provided, and all Plant acquired, or subject to a legally binding obligation to purchase, by the Contractor and used or intended to be used for the purpose of the Facilities, up to and including the date of termination. If the Engineer-in-charge fails to certify an Interim Payment Certificate in accordance with Sub-Clause 15.5 [Issue of Interim Payment Certificates] or fails to make a payment of an Interim Payment Certificate within time period specified in accordance with Sub-Clause 15.6 [Payment of an Interim Payment Certificate], the Contractor may, after giving not less than 21 Days' notice to the Procuring Entity, suspend work (or reduce the rate of progress of work) unless and until the Contractor has received the Payment Certificate or payment, as the case may be as described in the notice. If the Contractor subsequently receives such Payment Certificate or payment (as described in the relevant Sub-Clause and in the above notice) before giving a notice of termination, the Contractor shall resume normal working as soon as is reasonably practicable. If the Contractor suffers delay and/ or incurs Cost as a result of suspending the Works (or reducing the rate of progress of the Works) in accordance with this Sub-Clause, the Contractor shall give notice to the Engineer-in-charge and shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion], and ii payment of any such Cost, which shall be included in the Contract Price. After receiving this notice, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.
Termination by Contractor	**17.2**	The Contractor shall be entitled to terminate the Contract if: i the Contractor does not receive the amount due under an Interim Payment Certificate within 28 Days after the expiry of the time stated in Sub-Clause

		15.6 [Payment of an Interim Payment Certificate] within which payment is to be made (except for deductions in accordance with Sub-Clause 2.5 [Procuring Entity's Claims], or ii the Procuring Entity substantially fails to perform his obligations under the Contract in such manner as to materially and adversely affect the economic balance of the Contract and/ or the ability of the Contractor to perform the Contract, or iii a prolonged suspension affects the whole of the Works as described in Sub-Clause 8.13 [Prolonged Suspension], or iv the Contractor does not receive the Engineer-in-charge's instruction recording the agreement of both Parties on the fulfilment of the conditions for the Commencement of Works under Sub-Clause 8.3 [Commencement of Works]. In any of these events or circumstances, the Contractor may, upon giving 28 Days' reasoned notice to the Procuring Entity, terminate the Contract.
Cessation of Work and Removal of Contractor's Equipment	**17.3**	After a notice of termination under Sub-Clause 16 [Termination of Contract by Procuring Entity], Sub-Clause 17.2 [Termination by Contractor] or Sub-Clause 19.6. [Optional Termination, Payment and Release] has taken effect, the Contractor shall promptly: i cease all further work, except for such work as may have been instructed by the Engineer-in-charge for the protection of life or property or for the safety of the Works, ii hand over Contractor's Documents, as built drawings, Plant, Materials and other work, for which the Contractor has received payment, and iii remove all other Goods from the Site, except as necessary for safety, and leave the Site.
Payment on Termination	**17.4**	After a notice of termination under Sub-Clause 17.2 [Termination by Contractor] has taken effect, the Procuring Entity shall promptly pay the Contractor in accordance with Sub-Clause 19.6. [Optional Termination, Payment and Release].
18. Risk and responsibilities		
Indemnities	**18.1**	The Contractor shall indemnify and hold harmless the Procuring Entity, the Procuring Entity's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of: i bodily injury, sickness, disease or death, of any person whatsoever arising out of or in the course of or by reason of the Contractor's design (if any), the execution and completion of the Works and the remedying of any Defects, unless attributable to any negligence, willful act or breach of the Contract by the Procuring Entity, the Procuring Entity's Personnel, or any of their respective agents, and ii damage to or loss of any property, real or personal (other than the Works), to the extent that such damage or loss arises out of or in the course of or by reason of the Contractor's design (if any), the execution and completion of the Works and the remedying of any Defects, unless and to the extent that any such damage or loss is attributable to any negligence, willful act or breach of the Contract by the Procuring Entity, the Procuring Entity's Personnel, their respective agents, or anyone directly or indirectly employed by any of them.
Contractor's Care of the Works	**18.2.1**	The Contractor shall take full responsibility for the care of the Works and materials and Goods from the Commencement Date until the Taking-Over Certificate is issued (or is deemed to be issued under Clause 12 [Taking Over of the Works and

		Sections by Procuring Entity] for the Works, when responsibility for the care of the Works shall pass to the Procuring Entity. If a Taking-Over Certificate is issued (or is so deemed to be issued) for any Section or part of the Works, responsibility for the care of the Section or part shall then pass to the Procuring Entity. After responsibility has accordingly passed to the Procuring Entity, the Contractor shall take responsibility for the care of any work which is outstanding on the date stated in a Taking-Over Certificate, until this outstanding work has been completed. If any loss or damage happens to the Works, Materials or Goods or Contractor's Documents during the period when the Contractor is responsible for their care, from any cause not listed in Sub-Clause 18.3 [Procuring Entity's Risks], the Contractor shall rectify/ reimburse the loss or damage at the Contractor's risk and Cost, so that the Works, Materials or Goods or Contractor's Documents conform with the Contract. The Contractor shall be liable for any loss or damage caused by any actions performed by the Contractor after a Taking-Over Certificate has been issued. The Contractor shall also be liable for any loss or damage which occurs after a Taking Over Certificate has been issued and which arose from a previous event for which the Contractor was liable.
	18.2.2	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.
Procuring Entity's Risks.	**18.3**	The risks referred to in Sub-Clause 18.4 [Consequences of Procuring Entity's Risks] below, insofar as they directly affect the execution of the Works, are: i war, hostilities (whether war be declared or not), invasion, act of foreign enemies, ii rebellion, terrorism, sabotage by persons other than the Contractor's Personnel, revolution, insurrection, military or usurped power, or civil war, within the Country, iii riot, commotion or disorder within the Country by persons other than the Contractor's Personnel, iv munitions of war, explosive Materials, ionizing radiation or contamination by radio-activity, within the Country, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity, v pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds, vi use or occupation by the Procuring Entity of any part of the Permanent Works, except as may be specified in the Contract, vii design of any part of the Works by the Procuring Entity's Personnel or by others for whom the Procuring Entity is responsible, and viii Any operation of the forces of nature which is Unforeseeable or against which an experienced Contractor could not reasonably have been expected to have taken adequate preventive precautions.
Consequences of Procuring Entity's Risks	**18.4**	If and to the extent that any of the risks listed in Sub-Clause 18.3 above results in loss or damage to the Works, materials or Goods or Contractor's Documents, the Contractor shall promptly give notice to the Engineer-in-charge and shall rectify this loss or damage to the extent required by the Engineer-in-charge. If the Contractor suffers delay and/ or incurs Cost from rectifying this loss or damage, the Contractor shall give a further notice to the Engineer-in-charge and shall be entitled subject to Clause 21.2 [Contractor's Claims] to: i An extension of time for any such delay, if completion is or will be delayed, under Clause 8.6 [Extension of Time for Completion], and ii payment of any such Cost, which shall be included in the Contract Price. After receiving this further notice, the Engineer-in-charge shall proceed in accordance with Clause 3.5 [Determinations] to agree or determine these mattes.

Intellectual and Industrial Property Rights	**18.5**	In this Sub-Clause, "infringement" means an infringement (or alleged infringement) of any patent, registered design, copyright, trade mark, trade name, trade secret or other intellectual or industrial property right relating to the Works; and "claim" means a claim (or proceedings pursuing a claim) alleging an infringement. Whenever a Party does not give notice to the other Party of any claim within 28 Days of receiving the claim, the first Party shall be deemed to have waived any right to indemnity under this Sub-Clause. The Contractor shall fully indemnify and keep indemnified the Procuring Entity and the State Government 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. The Contractor shall indemnify and hold the Procuring Entity harmless against and from any other claim which arises out of or in relation to (i) the manufacture, use, sale or import of any Goods, or (ii) any design for which the Contractor is responsible. The Procuring Entity shall indemnify and hold the Contractor harmless against and from any claim alleging an infringement which is or was: i an unavoidable result of the Contractor's compliance with the Contract, or ii a result of any Works being used by the Procuring Entity: (a) for a purpose other than that indicated by, or reasonably to be inferred from, the Contract, or (b) in conjunction with anything not supplied by the Contractor, unless such use was disclosed to the Contractor prior to the Base Date or is stated in the Contract If a Party is entitled to be indemnified under this Sub-Clause, the indemnifying Party may (at its Cost) conduct negotiations for the settlement of the claim, and any litigation or arbitration which may arise from it. The other Party shall, at the request and Cost of the indemnifying Party, assist in contesting the claim. This other Party (and its Personnel) shall not make any admission which might be prejudicial to the indemnifying Party, unless the indemnifying Party failed to take over the conduct of any negotiations, litigation or arbitration upon being requested to do so by such other Party.
Use of Procuring Entity's Accommodation/ Facilities	18.6	The Contractor shall take full responsibility for the care of the accommodation and facilities, if any, provided by the Procuring Entity as detailed in the Specifications, from the respective dates of hand-over to the Contractor until cessation of occupation (where hand-over or cessation of occupation may take place after the date stated in the Taking-Over Certificate for the Works). If any loss or damage happens to any of the above items while the Contractor is responsible for their care arising from any cause whatsoever other than those for which the Procuring Entity is liable, the Contractor shall, at his own cost, rectify the loss or damage to the satisfaction of the Engineer-in-Charge.
19. Force Majeure		
Definition of Force Majeure	**19.1**	In this Sub-Clause, "Force Majeure" means an exceptional event or circumstance: i. which is beyond a Party's control, ii. which such Party could not reasonably have provided against before entering into the Contract, iii. which, having arisen, such Party could not reasonably have avoided or overcome, and iv. which is not substantially attributable to the other Party. Force Majeure may include, but is not limited to, exceptional events or circumstances of the kind listed below, so long as conditions (i) to (iv) above are satisfied: (a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies,

		(b) rebellion, terrorism, sabotage by persons other than the Contractor's Personnel, revolution, insurrection, military or usurped power, or civil war, (c) riot, commotion, disorder, strike or lockout by persons other than the Contractor's Personnel, (d) munitions of war, explosive Materials, ionizing radiation or contamination by radio-activity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity, and (e) natural catastrophes such as earthquake, hurricane, typhoon or volcanic activity.
Notice of Force Majeure	**19.2**	If a Party is or will be prevented from performing its substantial obligations under the Contract by Force Majeure, then it shall give notice to the other Party of the event or circumstances constituting the Force Majeure and shall specify the obligations, the performance of which is or will be prevented. The notice shall be given within 14 Days after the Party became aware, or should have become aware, of the relevant event or circumstance constituting Force Majeure. The Party shall, having given notice, be excused performance of its obligations for so long as such Force Majeure prevents it from performing them. Notwithstanding any other provision of this Clause, Force Majeure shall not apply to obligations of either Party to make payments to the other Party under the Contract.
Duty to Minimize Delay	**19.3**	Each Party shall at all times use all reasonable endeavours to minimize any delay in the performance of the Contract as a result of Force Majeure. A Party shall give notice to the other Party when it ceases to be affected by the Force Majeure.
Consequences of Force Majeure	**19.4**	If the Contractor is prevented from performing its substantial obligations under the Contract by Force Majeure of which notice has been given under Sub-Clause 19.2 [Notice of Force Majeure], and suffers delay and/ or incurs Cost by reason of such Force Majeure, the Contractor shall be entitled subject to Sub-Clause 21.2 [Contractor's Claims] to: i. an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.6 [Extension of Time for Completion], and ii. if the event or circumstance is of the kind described in Sub-Clause 19.1 [Definition of Force Majeure] and, in the case of sub-paragraphs (a) to (e), occurs in the Country, payment of any such Cost incurred rectifying or replacing the Works and/ or Goods damaged or destructed by Force Majeure, to the extent they are not indemnified through the insurance policy referred to in Sub-Clause 20.2 [Insurance for Works and Contractor's Equipment]. After receiving this notice, the Engineer-in-charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine these matters.
Force Majeure Affecting Subcontractor	**19.5**	If any Subcontractor is entitled under any Contract or agreement relating to the Works to relief from force majeure on terms additional to or broader than those specified in this Sub-Clause, such additional or broader force majeure events or circumstances shall not excuse the Contractor's non-performance or entitle him to relief under this Sub-Clause.

Optional Termination, Payment and Release	**19.6**	If the execution of substantially all the Works in progress is prevented for a continuous period of 84 Days by reason of Force Majeure of which notice has been given under Sub-Clause 19.2 [Notice of Force Majeure], or for multiple periods which total more than 140 Days due to the same notified Force Majeure, then either Party may give to the other Party a notice of termination of the Contract. In this event, the termination shall take effect 7 Days after the notice is given, and the Contractor shall proceed in accordance with Sub-Clause 17.3 [Cessation of Works and Removal of Contractor's Equipment]. Upon such termination, the Engineer-in-charge shall determine the value of the work done and issue a Payment Certificate which shall include: i the amounts payable for any acceptable work carried out for which a price is stated in the Contract; ii the Cost of Plant and Materials ordered for the Works which have been delivered to the Contractor, or of which the Contractor is liable to accept delivery: this Plant and Materials shall become the property of (and be at the risk of) the Procuring Entity when paid for by the Procuring Entity, and the Contractor shall place the same at the Procuring Entity's disposal; iii other Costs or liabilities which in the circumstances were reasonably and necessarily incurred by the Contractor in the expectation of completing the Works; iv the Cost of removal of Temporary Works and Contractor's Equipment from the Site.
Release from Performance	**19.7**	Notwithstanding any other provision of this Clause, if any event or circumstance outside the control of the Parties (including, but not limited to, Force Majeure) arises which makes it impossible or unlawful for either or both Parties to fulfill its or their Contractual obligations or which, under the Law governing the Contract, entitles the Parties to be released from further performance of the Contract, then upon notice by either Party to the other Party of such event or circumstance: i The Parties shall be discharged from further performance, without prejudice to the rights of either Party in respect of any previous breach of the Contract, and ii the sum payable by the Procuring Entity to the Contractor shall be the same as would have been payable under Sub-Clause 19.6 [Optional Termination, Payment and Release] if the Contract had been terminated under Sub-Clause 19.6.
20. Insurance		
General Requirements for Insurance	**20.1**	In this Sub-Clause, "insuring Party" means, for each type of insurance, the Party responsible for effecting and maintaining the insurance specified in the relevant Sub-Clause. Wherever the Contractor is the insuring Party, each insurance shall be effected with insurers and in terms approved by the Procuring Entity. These terms shall be consistent with any terms agreed by both Parties before the date of the Letter of Acceptance. This agreement of terms shall take precedence over the provisions of this Sub-Clause. Wherever the Procuring Entity is the insuring Party, each insurance shall be effected with insurers and in terms acceptable to the Contractor. These terms shall be consistent with any terms agreed by both Parties before the date of the Letter of Acceptance. This agreement of terms shall take precedence over the provisions of this Sub-Clause. If a policy is required to indemnify joint insured, the cover shall apply separately to each insured as though a separate policy had been issued for each of the joint insured. If a policy indemnifies additional joint insured, namely in addition to the insured specified in this Sub-Clause, (i) the Contractor shall act under the policy on behalf of these additional joint insured except that the Procuring Entity shall act for Procuring Entity's Personnel, (ii) additional joint insured shall not be entitled to

		receive payments directly from the insurer or to have any other direct dealings with the insurer, and (iii) the insuring Party shall require all additional joint insured to comply with the conditions stipulated in the policy. Each policy insuring against loss or damage shall provide for payments to be made in the currencies required to rectify the loss or damage. Payments received from insurers shall be used for the rectification of the loss or damage. The relevant insuring Party shall, within the respective periods stated in the Contract Data (calculated from the Commencement Date), submit to the other Party: i evidence that the insurances described in this Sub-Clause have been effected, and ii copies of the policies for the insurances described in Sub-Clause 20.2 [Insurance for Works and Contractor's Equipment] and Sub-Clause 20.3 [Insurance against Injury to Persons and Damage to Property]. When each premium is paid, the insuring Party shall submit evidence of payment to the other Party. Whenever evidence or policies are submitted, the insuring Party shall also give notice to the Engineer-in-charge. Each Party shall comply with the conditions stipulated in each of the insurance policies. The insuring Party shall keep the insurers informed of any relevant changes to the execution of the Works and ensure that insurance is maintained in accordance with this Sub-Clause. Neither Party shall make any material alteration to the terms of any insurance without the prior approval of the other Party. If an insurer makes (or attempts to make) any alteration, the Party first notified by the insurer shall promptly give notice to the other Party. If the insuring Party fails to effect and keep in force any of the insurances it is required to effect and maintain under the Contract, or fails to provide satisfactory evidence and copies of policies in accordance with this Sub-Clause, the other Party may (at its option and without prejudice to any other right or remedy) effect insurance for the relevant coverage and pay the premiums due. The insuring Party shall pay the amount of these premiums to the other Party, and the Contract Price shall be adjusted accordingly. Nothing in this Sub-Clause limits the obligations, liabilities or responsibilities of the Contractor or the Procuring Entity, under the other terms of the Contract or otherwise. Any amounts not insured or not recovered from the insurers shall be borne by the Contractor and/ or the Procuring Entity in accordance with these obligations, liabilities or responsibilities. However, if the insuring Party fails to effect and keep in force an insurance which is available and which it is required to effect and maintain under the Contract, and the other Party neither approves the omission nor effects insurance for the coverage relevant to this default, any moneys which should have been recoverable under this insurance shall be paid by the insuring Party. Payments by one Party to the other Party shall be subject to Sub-Clause 2.5 [Procuring Entity's Claims] or Sub-Clause 21.2 [Contractor's Claims], as applicable.
Cargo Insurance	**20.2**	Covering loss or damage occurring, while in transit from the supplier's or manufacturer's works or stores until arrival at the Site, to the Facilities (including spare parts therefore) and to the construction equipment to be provided by the Contractor or its Subcontractors.
Installation All Risks Insurance	**20.3**	Covering physical loss or damage to the Facilities at the Site, occurring prior to completion of the Facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the defect liability period while the Contractor is on the Site for the purpose of performing its obligations during the defect liability period.

Third Party Liability Insurance	**20.4**	Covering bodily injury or death suffered by third parties (including the Employer's personnel) and loss of or damage to property (including the Employer's property and any parts of the Facilities that have been accepted by the Employer) occurring in connection with the supply and installation of the Facilities. **A) Insurance against Injury to Persons and Damage to Property** The insuring Party shall insure against each Party's liability for any loss, damage, death or bodily injury which may occur to any physical property (except things insured under Sub-Clause 20.2 [Insurance for Works and Contractor's Equipment]) or to any person (except persons insured under Sub-Clause 20.4 [Insurance for Contractor's Personnel]), which may arise out of the Contractor's performance of the Contract and occurring before the issue of the Performance Certificate. This insurance shall be for a limit per occurrence of not less than the amount stated in the Contract Data with no limit on the number of occurrences. Unless otherwise stated in the Special Conditions, the insurances specified in this Sub-Clause: i shall be effected and maintained by the Contractor as insuring Party, ii shall be in the joint names of the Parties, iii shall be extended to cover liability for all loss and damage to the Procuring Entity's property (except things insured under Sub-Clause 20.2 [Insurance for Works and Contractor's Equipment] arising out of the Contractor's performance of the Contract, and iv may however exclude liability to the extent that it arises from: (a) the Procuring Entity's right to have the Permanent Works executed on, over, under, in or through any land, and to occupy this land for the Permanent Works, (b) damage which is an unavoidable result of the Contractor's obligations to execute the Works and remedy any Defects, and a cause listed in Sub-Clause 18.3 [Procuring Entity's Risks], except to the extent that cover is available at commercially reasonable terms. **B) Insurance for Contractor's Personnel** The Contractor shall effect and maintain insurance against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor's Personnel. The insurance shall cover the Procuring Entity and the Engineer-in-charge against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor's Personnel, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Procuring Entity or of the Procuring Entity's Personnel. The insurance shall be maintained in full force and effect during the whole time that these personnel are assisting in the execution of the Works. For a Subcontractor's employees, the insurance may be effected by the Subcontractor, but the Contractor shall be responsible for compliance with this Sub-Clause.
Automobile Liability Insurance	**20.5**	Covering use of all vehicles used by the Contractor or its Subcontractors (whether owned by them or not) in connection with the supply and installation of the Facilities. Comprehensive insurance in accordance with statutory requirements.
Workers' Compensation		In accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.

Employer's Liability		In accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.
Other Insurance	**20.5**	The Contractor is also required to take out and maintain at its own cost the following types of insurance:
Insurance for Works and Contractor's Equipment	**20.5.1** .	The insuring Party shall insure the Works, Plant, Materials and Contractor's Documents for not less than the full reinstatement Cost including the Costs of demolition, removal of debris and professional fees and profit. This insurance shall be effective from the date by which the evidence is to be submitted under Sub-Clause 20.1 [General Requirements for Insurances], until the date of issue of the Taking-Over Certificate for the Works. The insuring Party shall maintain this insurance to provide cover until the date of issue of the Performance Certificate, for loss or damage for which the Contractor is liable arising from a cause occurring prior to the issue of the Taking-Over Certificate, and for loss or damage caused by the Contractor in the course of any other operations including those under Clause 13 [Defect Liability]. The insuring Party shall insure the Contractor's Equipment for not less than the full replacement value, including delivery to Site. For each item of Contractor's Equipment, the insurance shall be effective while it is being transported to the Site and until it is no longer required as Contractor's Equipment. Unless otherwise stated in the Special Conditions, insurances under this Sub-Clause: i shall be effected and maintained by the Contractor as insuring Party, ii shall be in the joint names of the Parties, who shall be jointly entitled to receive payments from the insurers, payments being held or allocated to the Party actually bearing the Costs of rectifying the loss or damage, iii shall be extended to cover liability for all loss and damage from any cause not listed in Sub-Clause 18.3 [Procuring Entity's Risks], iv shall also cover, to the extent specifically required in the Contract Data, loss or damage to a part of the Works which is attributable to the use or occupation by the Procuring Entity of another part of the Works, and loss or damage from the risks listed in Sub-Clause 18.3 [Procuring Entity's Risks], excluding (in each case) risks which are not insurable at commercially reasonable terms, and v may however exclude loss of, damage to, and reinstatement of: (a.) a part of the Works which is in a defective condition due to a defect in its design, materials or workmanship (but cover shall include any other parts which are lost or damaged as a direct result of this defective condition and not as described in sub- paragraph (b) below), (b.) a part of the Works which is lost or damaged in order to reinstate any other part of the Works if this other part is in a defective condition due to a defect in its design, material or workmanship, and A part of the Works which has been taken over by the Procuring Entity, except to the extent that the Contractor is liable for the loss or damage.
	20.5.2	Any other such item mentioned in SCC of this bid document
21. Claims, disputes and Arbitration		
Recovery	**21.1.1**	Any amount inadvertently paid as not due to the Contractor shall be treated as acknowledged recovery/ or debt due from the Contractor. The Contractor shall immediately inform the Engineer-in-charge about such amount and offer to reimburse immediately to the Engineer-in-charge.
	21.1.2	Whenever any claim against the Contractor for the payment of a sum of money arises out of or under the Contract, the Procuring Entity shall be entitled to recover such a sum by appropriating, in part or whole of the Performance Security, or enlistment deposit of the Contractor. In the event of the Performance Security and

		enlistment deposit being insufficient or if no Performance Security has been taken, then the balance or the total sum recoverable, as the case may be, shall be deducted from any sum, then due or which at any time, thereafter, may become due to the Contractor, under this Contract or other Contracts with the Procuring Entity. Should these sums not be sufficient to cover the full amount recoverable, the balance remaining due shall be recovered from the Contractor as arrears of land revenue under Section 53 of the Act.
Contractor's Claims	**21.2**	If the Contractor considers himself to be entitled to any extension of the Time for Completion and/ or any additional payment, under any Sub-Clause of these Conditions or otherwise in connection with the Contract, the Contractor shall give notice to the Engineer-in-charge, describing the event or circumstance giving rise to the claim. The notice shall be given as soon as practicable, but not later than 28 Days after the Contractor became aware, or should have become aware, of the event or circumstance. If the Contractor fails to give notice of a claim within such period of 28 Days, the Time for Completion shall not be extended, the Contractor shall not be entitled to additional payment, and the Procuring Entity shall be discharged from all liability in connection with the claim. Otherwise, the following provisions of this Sub-Clause shall apply. The Contractor shall also submit any other notices which are required by the Contract, and supporting particulars for the claim, all as relevant to such event or circumstance. The Contractor shall keep such contemporary records as may be necessary to substantiate any claim included in the claim, either on the Site or at another location acceptable to the Engineer-in-charge. Without admitting the Procuring Entity's liability, the Engineer-in-charge may, after receiving any notice under this Sub-Clause, monitor the record-keeping and/ or instruct the Contractor to keep further contemporary records. The Contractor shall permit the Engineer-in-charge to inspect all these records, and shall (if instructed) submit copies to the Engineer-in-charge. Within 42 Days after the Contractor became aware (or should have become aware) of the event or circumstance giving rise to the claim, or within such other period as may be proposed by the Contractor and approved by the Engineer-in-charge, the Contractor shall send to the Engineer-in-charge a fully detailed claim which includes full supporting particulars of the basis of the claim and of the extension of time and/or additional payment claimed. If the event or circumstance giving rise to the claim has a continuing effect: i. this fully detailed claim shall be considered as interim; ii. the Contractor shall send further interim claims at monthly intervals, giving the accumulated delay and/ or amount claimed, and such further particulars as the Engineer-in-charge may reasonably require; and iii. the Contractor shall send a final claim within 28 Days after the end of the effects resulting from the event or circumstance, or within such other period as may be proposed by the Contractor and approved by the Engineer-in-charge. Within 42 Days after receiving a claim or any further particulars supporting a previous claim, or within such other period as may be proposed by the Engineer-in-charge and approved by the Contractor, the Engineer-in-charge shall respond with approval, or with disapproval and detailed comments. He may also request any necessary further particulars, but shall nevertheless give his response on the principles of the claim within the above defined time period. Within the above defined period of 42 Days, the Engineer-in- charge shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine (i) the extension (if any) of the Time for Completion (before or after its expiry) in accordance with Sub-Clause 8.6 [Extension of Time for Completion], and/ or (ii)

		the additional payment (if any) to which the Contractor is entitled under the Contract. Each Payment Certificate shall include such additional payment for any claim as have been reasonably substantiated as due under the relevant provision of the Contract. Unless and until the particulars supplied are sufficient to substantiate the whole of the claim, the Contractor shall only be entitled to payment for such part of the claim as he has been able to substantiate. If the Engineer-in-charge does not respond within the timeframe defined in this Sub-Clause, the matter may be brought to the attention of the Procuring Entity by the Contractor within 15 days (beyond the initial period of 42 days) for timely intervention. If the Contractor is not satisfied with the decision of the Engineer-in-charge/ Procuring Entity, the Parties may refer the dispute to the Dispute Resolution Board in accordance with Sub-Clause 21.3 [Dispute Resolution]. The requirements of this Sub-Clause are in addition to those of any other Sub-Clause which may apply to a claim. If the Contractor fails to comply with this or another Sub-Clause in relation to any claim, any extension of time and/ or additional payment shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the claim, unless the claim is excluded under the second paragraph of this Sub-Clause.
Dispute Resolution	**21.3.1**	The procedure of reference of disputes to the Dispute Resolution Board and its functioning shall be as per Appendix B.
	21.3.2	The disputes which remain unresolved by the Dispute Resolution Board may be referred by either Party to Arbitration.
22.0 Installation		
		22.1 Setting Out/Supervision 22.1.1 Benchmark (a) The Contractor shall be responsible for the true and proper setting-out of the Facilities in relation to bench marks, reference marks, and lines provided to it in writing by or on behalf of the Employer. (b) If, at any time during the progress of installation of the Facilities, any error shall appear in the position, level, or alignment of the Facilities, the Contractor shall forthwith notify the EIC of such error and, at its own expense, immediately rectify such error to the reasonable satisfaction of the EIC. If such error is based on incorrect data provided in writing by or on behalf of the Employer, the expense of rectifying the same shall be borne by the Employer. 22.1.2 Contractor's Supervision The Contractor shall give or provide all necessary superintendence during the installation of the Facilities, and the Construction Manager or its deputy shall be constantly on the Site to provide full-time superintendence of the installation. The Contractor shall provide and employ only technical personnel who are skilled and experienced in their respective callings and supervisory staff who are competent to adequately supervise the work at hand. 22.2 Labor 22.2.1 Engagement of Staff and Labor (a) Except as otherwise stated in the Specification, the Contractor shall make arrangements for the engagement of all staff and labor, local or otherwise, and for their payment, housing, feeding, and transport.

		(b) The Contractor shall provide and employ on the Site in the installation of the Facilities such skilled, semi-skilled, and unskilled labor as is necessary for the proper and timely execution of the Contract. The Contractor is encouraged to use local labor that has the necessary skills. (c) The Contractor shall be responsible for obtaining all necessary permit(s) and/or visa(s) from the appropriate authorities for the entry of all labor and personnel to be employed on the Site into the country where the Site is located. The Employer will, if requested by the Contractor, use his best endeavors in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national, or government permission required for bringing in the Contractor's personnel. (d) The Contractor shall at its own expense provide the means of repatriation to all of its and its Subcontractor's personnel employed on the Contract at the Site to the place where they were recruited or to their domicile. It shall also provide suitable temporary maintenance of all such persons from the cessation of their employment on the Contract to the date programmed for their departure. In the event that the Contractor defaults in providing such means of transportation and temporary maintenance, the Employer may provide the same to such personnel and recover the cost of doing so from the Contractor. 22.2.2 Persons in the Service of Employer The Contractor shall not recruit, or attempt to recruit, staff and labor from amongst the Employer's Personnel. 22.2.3 Labor Laws (a) The Contractor shall comply with all the relevant labor Laws applicable to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration, and emigration, and shall allow them all their legal rights. (b) The Contractor shall at all times during the progress of the Contract use its best endeavors to prevent any unlawful, riotous, or disorderly conduct or behavior by or amongst its employees and the labor of its Subcontractors. (c) The Contractor shall, in all dealings with its labor and the labor of its Subcontractors currently employed on or connected with the Contract, pay due regard to all recognized festivals, official holidays, religious, or other customs and all local laws and regulations pertaining to the employment of labor. 22.2.4 Rates of Wages and Conditions of Labor (a) The Contractor shall pay rates of wages, and observe conditions of labor, which are not lower than those established for the trade or industry where the work is carried out. If no established rates or conditions are applicable, the Contractor shall pay rates of wages and observe conditions which are not lower than the general level of wages and conditions observed locally by employers whose trade or industry is similar to that of the Contractor. (b) The Contractor shall inform the Contractor's Personnel about their liability to pay personal income taxes in the Country in respect of such of their salaries,

wages, and allowances as are chargeable under the Laws for the time being in force, and the Contractor shall perform such duties in regard to such deductions thereof as may be imposed on him by such Laws.

22.2.5 Working Hours

(a) No work shall be carried out on the Site on locally recognized days of rest, or outside the normal working hours stated in the SCC, unless

(i) otherwise stated in the Contract;

(ii) the EIC gives consent; or

(iii the work is unavoidable, or necessary for the protection of life or property or for the safety of the Works, in which case the Contractor shall immediately advise the EIC.

(b) If and when the Contractor considers it necessary to carry out work at night or on public holidays so as to meet the Time for Completion and requests the EIC's consent thereto, the EIC shall not unreasonably withhold such consent.

(c) This Subclause shall not apply to any work which is customarily carried out by rotary or double shifts.

22.2.6 Facilities for Staff and Labor

(a) Except as otherwise stated in the Specification, the Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel. The Contractor shall also provide facilities for the Employer's Personnel as stated in the Specification.

(b) The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the structures forming part of the Permanent Works.

22.2.7 Health and Safety

(a) The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities, the Contractor shall ensure that medical staff, first aid facilities, sick bay, and ambulance service are available at all times at the Site and at any accommodation for Contractor's and Employer's Personnel, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics.

(b) The Contractor shall appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this responsibility, and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the performance of the Contract, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority.

(c) The Contractor shall send to the EIC, details of any accident as soon as practicable after its occurrence. The Contractor shall maintain records and

		make reports concerning health, safety, and welfare of persons, and damage to property, as the EIC may reasonably require. 22.2.8 Records of Contractor's Personnel The Contractor shall keep accurate records of the Contractor's personnel, including the number of each class of Contractor's Personnel on the Site and the names, ages, gender, hours worked, and wages paid to all workers. These records shall be summarized on a monthly basis in a form approved by the EIC and shall be available for inspection by the EIC until the Contractor has completed all work. 22.2.9 Supply of Foodstuff The Contractor shall arrange for the provision of a sufficient supply of suitable food as may be stated in the Specification at reasonable prices for the Contractor's Personnel for the purposes of or in connection with the Contract. 22.2.10 Supply of Water The Contractor shall, having regard to local conditions, provide on the Site an adequate supply of drinking and other water for the use of the Contractor's Personnel. 22.2.11 Measures against Insect and Pest Nuisance The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce their danger to health. The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide. 22.2.12 Alcoholic Liquor or Drugs The Contractor shall not, otherwise than in accordance with the Laws of the Country, import, sell, give barter, or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift barter, or disposal by Contractor's Personnel. 22.2.13 Arms and Ammunition The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms or ammunition of any kind, or allow Contractor's Personnel to do so. 22.2.14 Prohibition of All Forms of Forced or Compulsory Labor The contractor shall not employ "forced or compulsory labor" in any form. "Forced or compulsory labor" consists of all work or service, not voluntarily performed, that is extracted from an individual under threat of force or penalty. 22.2.15 Prohibition of Harmful Child Labor The Contractor shall not employ any child to perform any work that is economically exploitative, or is likely to be hazardous to, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development.

		22.3 Contractor's Equipment 22.3.1 All Contractor's Equipment brought by the Contractor onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Contractor shall not remove the same from the Site without the EIC's consent that such Contractor's Equipment is no longer required for the execution of the Contract. 22.3.2 Unless otherwise specified in the Contract, upon completion of the Facilities, the Contractor shall remove from the Site all Equipment brought by the Contractor onto the Site and any surplus materials remaining thereon. 22.3.3 The Employer will, if requested, use its best endeavors to assist the Contractor in obtaining any local, state or national government permission required by the Contractor for the export of the Contractor's Equipment imported by the Contractor for use in the execution of the Contract that is no longer required for the execution of the Contract. 22.4 Site Regulations and Safety The Employer and the Contractor shall establish Site regulations setting out the rules to be observed in the execution of the Contract at the Site and shall comply therewith. The Contractor shall prepare and submit to the Employer, with a copy to the EIC, proposed Site regulations for the Employer's approval, which approval shall not be unreasonably withheld. Such Site regulations shall include, but shall not be limited to, rules in respect of security, safety of the Facilities, gate control, sanitation, medical care, and fire prevention. 22.5 Opportunities for Other Contractors 22.5.1 The Contractor shall, upon written request from the Employer or the EIC, give all reasonable opportunities for carrying out the work to any other contractors employed by the Employer on or near the Site. 22.5.2 If the Contractor, upon written request from the Employer or the EIC, makes available to other contractors any roads or ways the maintenance for which the Contractor is responsible, permits the use by such other contractors of the Contractor's Equipment, or provides any other service of whatsoever nature for such other contractors, the Employer shall fully compensate the Contractor for any loss or damage caused or occasioned by such other contractors in respect of any such use or service, and shall pay to the Contractor reasonable remuneration for the use of such equipment or the provision of such services. 22.5.3 The Contractor shall also so arrange to perform its work as to minimize, to the extent possible, interference with the work of other contractors. The EIC shall determine the resolution of any difference or conflict that may arise between the Contractor and other contractors and the workers of the Employer in regard to their work. 22.5.4 The Contractor shall notify the EIC promptly of any defects in the other Contractors' work that come to its notice, and that could affect the Contractor's work. The EIC shall determine the corrective measures, if any, required to rectify the

		situation after inspection of the Facilities. Decisions made by the EIC shall be binding on the Contractor. 22.6 Emergency Work If, by reason of an emergency arising in connection with and during the execution of the Contract, any protective or remedial work is necessary as a matter of urgency to prevent damage to the Facilities, the Contractor shall immediately carry out such work. If the Contractor is unable or unwilling to do such work immediately, the Employer may do or cause such work to be done as the Employer may determine is necessary in order to prevent damage to the Facilities. In such event the Employer shall, as soon as practicable after the occurrence of any such emergency, notify the Contractor in writing of such emergency, the work done and the reasons therefor. If the work done or caused to be done by the Employer is work that the Contractor was liable to do at its own expense under the Contract, the reasonable costs incurred by the Employer in connection therewith shall be paid by the Contractor to the Employer. Otherwise, the cost of such remedial work shall be borne by the Employer. 22.7 Site Clearance 22.7.1 Site Clearance in Course of Performance In the course of carrying out the Contract, the Contractor shall keep the Site reasonably free from all unnecessary obstruction, store, or remove any surplus materials, clear away any wreckage, rubbish, or temporary works from the Site, and remove any Contractor's Equipment no longer required for execution of the Contract. 22.7.2 Clearance of Site after Completion After Completion of all parts of the Facilities, the Contractor shall clear away and remove all wreckage, rubbish, and debris of any kind from the Site, and shall leave the Site and Facilities in a clean and safe condition. 22.8 Watching and Lighting The Contractor shall provide and maintain at its own expense all lighting, fencing, and watching when and where necessary for the proper execution and the protection of the Facilities, or for the safety of the owners and occupiers of adjacent property and for the safety of the public.
Completion of Facilities	**24**	24.1 As soon as the Facilities or any part thereof has, in the opinion of the Contractor, been completed operationally and structurally and put in a tight and clean condition as specified in the Employer's Requirements, excluding minor items not materially affecting the operation or safety of the Facilities, the Contractor shall so notify the Employer in writing. 24.2 Within 7 days after receipt of the notice from the Contractor under GCC Subclause 24.1, the Employer shall supply the operating and maintenance personnel specified in the Appendix (Scope of Works and Supply by the Employer) to the Contract Agreement for Pre-commissioning of the Facilities or any part thereof.

		Pursuant to the Appendix (Scope of Works and Supply by the Employer) to the Contract Agreement, the Employer shall also provide, within the said 7-day period, the raw materials, utilities, lubricants, chemicals, catalysts, facilities, services, and other matters required for Pre-commissioning of the Facilities or any part thereof. 24.3 As soon as reasonably practicable after the operating and maintenance personnel have been supplied by the Employer and the raw materials, utilities, lubricants, chemicals, catalysts, facilities, services, and other matters have been provided by the Employer in accordance with GCC Subclause 24.2, the Contractor shall commence Pre-commissioning of the Facilities or the relevant part thereof in preparation for Commissioning, subject to GCC Subclause 25.5. 24.4 As soon as all works in respect of Pre-commissioning are completed and, in the opinion of the Contractor, the Facilities or any part thereof is ready for Commissioning, the Contractor shall so notify the EIC in writing. 24.5 The EIC shall, within 14 days after receipt of the Contractor's notice under GCC Subclause 24.4, either issue a Completion Certificate in the form specified in the Employer's Requirements (Forms and Procedures), stating that the Facilities or that part thereof have reached Completion as of the date of the Contractor's notice under GCC Subclause 24.4, or notify the Contractor in writing of any defects and/or deficiencies. If the EIC notifies the Contractor of any defects and/or deficiencies, the Contractor shall then correct such defects and/or deficiencies, and shall repeat the procedure described in GCC Subclause 24.4. If the EIC is satisfied that the Facilities or that part thereof have reached Completion, the EIC shall, within 7 days after receipt of the Contractor's repeated notice, issue a Completion Certificate stating that the Facilities or that part thereof have reached Completion as of the date of the Contractor's repeated notice. If the EIC is not so satisfied, then it shall notify the Contractor in writing of any defects and/or deficiencies within 7 days after receipt of the Contractor's repeated notice, and the above procedure shall be repeated. 24.6 If the EIC fails to issue the Completion Certificate and fails to inform the Contractor of any defects and/or deficiencies within 14 days after receipt of the Contractor's notice under GCC Subclause 24.4 or within 7 days after receipt of the Contractor's repeated notice under GCC Subclause 24.5, or if the Employer makes use of the Facilities or part thereof, then the Facilities or that part thereof shall be deemed to have reached Completion as of the date of the Contractor's notice or repeated notice, or as of the Employer's use of the Facilities, as the case may be. 24.7 As soon as possible after Completion, the Contractor shall complete all outstanding minor items so that the Facilities are fully in accordance with the requirements of the Contract, failing which the Employer will undertake such

		completion and deduct the costs thereof from any monies owing to the Contractor. 24.8 Upon Completion, the Employer shall be responsible for the care and custody of the Facilities or the relevant part thereof, together with the risk of loss or damage thereto, and shall thereafter take over the Facilities or the relevant part thereof.
Commissioning and Operational Acceptance	**25**	25.1 Commissioning 25.1.1 Commissioning of the Facilities or any part thereof shall be commenced by the Contractor immediately after issue of the Completion Certificate by the EIC, pursuant to GCC Subclause 24.5, or immediately after the date of the deemed Completion, under GCC Subclause 24.6. 25.1.2 The Employer shall supply the operating and maintenance personnel and all raw materials, utilities, lubricants, chemicals, catalysts, facilities, services, and other matters required for Commissioning. 25.1.3 In accordance with the requirements of the Contract, the Contractor's and EIC's advisory personnel shall attend the Commissioning, including the Guarantee Test, and shall advise and assist the Employer. 25.2 Guarantee Test 25.2.1 Subject to GCC Subclause 25.5, the Guarantee Test and repeats thereof shall be conducted by the Contractor during Commissioning of the Facilities or the relevant part thereof to ascertain whether the Facilities or the relevant part can attain the Functional Guarantees specified in the Appendix (Functional Guarantees) to the Contract Agreement. The Employer shall promptly provide the Contractor with such information as the Contractor may reasonably require in relation to the conduct and results of the Guarantee Test and any repeats thereof. 25.2.2 If for reasons not attributable to the Contractor, the Guarantee Test of the Facilities or the relevant part thereof cannot be successfully completed within the period from the date of Completion specified in the SCC or any other period agreed upon by the Employer and the Contractor, the Contractor shall be deemed to have fulfilled its obligations with respect to the Functional Guarantees, and GCC Subclauses 28.2 and 28.3 shall not apply. 25.3 Operational Acceptance 25.3.1 Subject to GCC Subclause 25.4 below, Operational Acceptance shall occur in respect of the Facilities or any part thereof when (a) the Guarantee Test has been successfully completed and the Functional Guarantees are met; or (b) the Guarantee Test has not been successfully completed or has not been carried out for reasons not attributable to the Contractor within the period from the date of Completion specified in the SCC, or any other agreed upon period as specified in GCC Subclause 25.2.2 above; or (c) the Contractor has paid the liquidated damages specified in GCC Subclause 8.9 hereof; and

		(d) any minor items mentioned in GCC Subclause 24.7 hereof relevant to the Facilities or that part thereof have been completed. 25.3.2 At any time after any of the events set out in GCC Subclause 25.3.1 have occurred, the Contractor may give a notice to the EIC requesting the issue of an Operational Acceptance Certificate in the form provided in the Employer's Requirements (Forms and Procedures) in respect of the Facilities or the part thereof specified in such notice as of the date of such notice. 25.3.3 The EIC shall, after consultation with the Employer, and within 7 days after receipt of the Contractor's notice, issue an Operational Acceptance Certificate. 25.3.4 If within 7 days after receipt of the Contractor's notice, the EIC fails to issue the Operational Acceptance Certificate or fails to inform the Contractor in writing of the justifiable reasons why the EIC has not issued the Operational Acceptance Certificate, the Facilities or the relevant part thereof shall be deemed to have been accepted as of the date of the Contractor's said notice. 25.4 Partial Acceptance 25.4.1 If the Contract specifies that Completion and Commissioning shall be carried out in respect of parts of the Facilities, the provisions relating to Completion and Commissioning including the Guarantee Test shall apply to each such part of the Facilities individually, and the Operational Acceptance Certificate shall be issued accordingly for each such part of the Facilities. 25.4.2 If a part of the Facilities comprises facilities such as buildings, for which no Commissioning or Guarantee Test is required, then the EIC shall issue the Operational Acceptance Certificate for such facility when it attains Completion, provided that the Contractor shall thereafter complete any outstanding minor items that are listed in the Operational Acceptance Certificate. 25.5 Delayed Pre-Commissioning and/or Guarantee Test 25.5.1 In the event that the Contractor is unable to proceed with the Pre-commissioning of the Facilities pursuant to Subclause 24.3, or with the Guarantee Test pursuant to Subclause 25.2, for reasons attributable to the Employer either on account of non-availability of other facilities under the responsibilities of other contractor(s), or for reasons beyond the Employer's control, the provisions leading to "deemed" completion of activities such as Completion, pursuant to GCC Subclause 24.6, and Operational Acceptance, pursuant to GCC Subclause 25.3.4, and Contractor's obligations regarding Defect Liability Period, pursuant to GCC Subclause 27.2, Functional Guarantee, pursuant to GCC Clause 28, and Care of Facilities, pursuant to GCC Clause 32, and GCC Clause 41.1, Suspension, shall not apply. In this case, the following provisions shall apply. 25.5.2 When the Contractor is notified by the EIC that he will be unable to proceed with the activities and obligations pursuant to above Subclause 25.5.1, the Contractor shall be entitled to the following: (a) the Time of Completion shall be extended for the period of suspension without imposition of liquidated damages pursuant to GCC Subclause 8.9;

		(b) payments due to the Contractor in accordance with the provision specified in the Appendix (Terms and Procedures of Payment) to the Contract Agreement, which would not have been payable in normal circumstances due to noncompletion of the subject activities, shall be released to the Contractor against submission of a security in the form of a bank guarantee of equivalent amount acceptable to the Employer, and which shall become null and void when the Contractor will have complied with its obligations regarding those payments, subject to the provision of Subclause 25.5.3 below; (c) the expenses towards the above security and extension of other securities under the contract, of which validity needs to be extended, shall be reimbursed to the Contractor by the Employer; (d) the additional charges towards the care of the Facilities pursuant to GCC Subclause 32.1 shall be reimbursed to the Contractor by the Employer for the period between the notification mentioned above and the notification mentioned in Subclause 25.5.4 below. The provision of GCC Subclause 33.2 shall apply to the Facilities during the same period. 25.5.3 In the event that the period of suspension under above Subclause 25.5.1 actually exceeds 180 days, the Employer and Contractor shall mutually agree to any additional compensation payable to the Contractor. 25.5.4 When the Contractor is notified by the EIC that the plant is ready for Pre-commissioning, the Contractor shall proceed without delay in performing all the specified activities and obligations under the contract.
Completion Time Guarantee	**26**	26.1 The Contractor guarantees that it shall attain Completion of the Facilities (or a part for which a separate time for completion is specified) within the Time for Completion specified in the SCC pursuant to GCC Subclause 8.4, or within such extended time to which the Contractor shall be entitled under GCC Clause 40 hereof. 26.2 If the Contractor fails to attain Completion of the Facilities or any part thereof within the Time for Completion or any extension thereof under GCC Clause 39, the Contractor shall pay to the Employer liquidated damages in the amount specified in the SCC as a percentage rate of the Contract Price or the relevant part thereof. The aggregate amount of such liquidated damages shall in no event exceed the amount specified as “Maximum” in the SCC as a percentage rate of the Contract Price. Once the “Maximum” is reached, the Employer may consider termination of the Contract, pursuant to GCC Subclause 17. Such payment shall completely satisfy the Contractor’s obligation to attain Completion of the Facilities or the relevant part thereof within the Time for Completion or any extension thereof under GCC Clause 39 The Contractor shall have no further liability whatsoever to the Employer in respect thereof. However, the payment of liquidated damages shall not in any way relieve the Contractor from any of its obligations to complete the Facilities or from any other obligations and liabilities of the Contractor under the Contract.

		Save for liquidated damages payable under this GCC Subclause 8.9, the failure by the Contractor to attain any milestone or other act, matter or thing by any date specified in the Appendix (Time Schedule) to the Contract Agreement and/or other program of work prepared pursuant to GCC Subclause 8.5 shall not render the Contractor liable for any loss or damage thereby suffered by the Employer. 26.3 If the Contractor attains Completion of the Facilities or any part thereof before the Time for Completion or any extension thereof under GCC Clause 40, the Employer shall pay to the Contractor a bonus in the amount specified in the SCC. The aggregate amount of such bonus shall in no event exceed the amount specified as "Maximum" in the SCC.
Functional Guarantees	**27**	27.1 The Contractor guarantees that during the Guarantee Test, the Facilities and all parts thereof shall attain the Functional Guarantees specified in the Appendix (Functional Guarantees) to the Contract Agreement, subject to, and upon the conditions therein specified. 27.2 If, for reasons attributable to the Contractor, the minimum level of the Functional Guarantees specified in the Appendix (Functional Guarantees) to the Contract Agreement are not met either in whole or in part, the Contractor shall at its cost and expense make such changes, modifications, and/or additions to the Plant or any part thereof as may be necessary to meet at least the minimum level of such Guarantees. The Contractor shall notify the Employer upon completion of the necessary changes, modifications, and/or additions, and shall request the Employer to repeat the Guarantee Test until the minimum level of the Guarantees has been met. If the Contractor eventually fails to meet the minimum level of Functional Guarantees, the Employer may consider termination of the Contract, pursuant to GCC Subclause 17 27.3 If, for reasons attributable to the Contractor, the Functional Guarantees specified in the Appendix (Functional Guarantees) to the Contract Agreement are not attained either in whole or in part, but the minimum level of the Functional Guarantees specified in the said Appendix to the Contract Agreement is met, the Contractor shall, at the Contractor's option, either (a) make such changes, modifications, and/or additions to the Facilities or any part thereof that are necessary to attain the Functional Guarantees at its cost and expense, and shall request the Employer to repeat the Guarantee Test or (b) pay liquidated damages to the Employer in respect of the failure to meet the Functional Guarantees in accordance with the provisions in the Appendix (Functional Guarantees) to the Contract Agreement. 27.4 The payment of liquidated damages under GCC Subclause 27.3, up to the limitation of liability specified in the Appendix (Functional Guarantees) to the Contract Agreement, shall completely satisfy the Contractor's guarantees under GCC Subclause 28.3, and the Contractor shall have no further liability whatsoever to the Employer in respect thereof. Upon the payment of such liquidated damages by the Contractor, the Project Manager shall issue the Operational Acceptance Certificate for the Facilities or any part thereof in respect of which the liquidated damages have been so paid.

Patent Indemnity	28.	28.1 The Contractor shall, subject to the Employer's compliance with GCC Subclause 28.2, indemnify and hold harmless the Employer and its employees and officers from and against any and all suits, actions, or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Employer may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright, or other intellectual property right registered or otherwise existing at the date of the Contract by reason of (a) the installation of the Facilities by the Contractor or the use of the Facilities in the country where the Site is located, and (b) the sale of the products produced by the Facilities in any country. Such indemnity shall not cover any use of the Facilities or any part thereof other than for the purpose indicated by or to be reasonably inferred from the Contract, any infringement resulting from the use of the Facilities or any part thereof, or any products produced thereby in association or combination with any other equipment, plant, or materials not supplied by the Contractor, pursuant to the Contract Agreement. 28.2 If any proceedings are brought or any claim is made against the Employer arising out of the matters referred to in GCC Subclause 28.1, the Employer shall promptly give the Contractor a notice thereof, and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim. If the Contractor fails to notify the Employer within 28 days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the 28-day period, the Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim. The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing. 28.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers, and Subcontractors from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Contractor may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright, or other intellectual property right registered or otherwise existing at the date of the Contract arising out of or in connection with any design, data, drawing, specification, or other documents or materials provided or designed by or on behalf of the Employer.
Limitation of Liability	29.	29.1 Except in cases of criminal negligence or willful misconduct, (a) the Contractor shall not be liable to the Employer, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss

		of production, or loss of profits or interest costs, provided that this exclusion shall not apply to any obligation of the Contractor to pay liquidated damages to the Employer, and (b) the aggregate liability of the Contractor to the Employer, whether under the Contract, in tort or otherwise, shall not exceed a multiple of the Contract Price specified in the SCC or, if a multiple is not so specified, the total Contract Price, provided that this limitation shall not apply to the cost of repairing or replacing defective equipment, or to any obligation of the Contractor to indemnify the Employer with respect to patent infringement. c) Neither Party shall be liable to the other Party for loss of use of any Works, loss of profit, loss of any Contract or for any indirect or consequential loss or damage which may be suffered by the other Party in connection with the Contract, other than as specifically provided in Sub-Clause 8.9 [Compensation/ Damages for Delay]; Sub-Clause 13.3 [Cost of Remedying Defects]; Sub-Clause 16.4 [Payment after Termination]; Sub-Clause 17.4 [Payment on Termination]; Sub-Clause 18.1 [Indemnities]; Sub-Clause 18.2 [Contractor's Care of the Works], Sub-Clause 18.4 [Consequences of Procuring Entity's Risks] and Sub-Clause 18.5. [Intellectual and Industrial Property Rights]. d) The total liability of the Contractor to the Procuring Entity, under or in connection with the Contract shall not exceed twice the Accepted Contract Amount. This amount does not include charges, if any, for consumption of Electricity, Water and Gas provided by the Procuring Entity under Sub-Clause 4.18 [Electricity, Water and Gas], and use of Procuring Entity's Equipment and Materials under Sub-Clause 4.19 [Procuring Entity's Equipment and Issue of Materials]. e) This Sub-Clause shall not limit liability of the Contractor in any case of fraud, deliberate default or reckless misconduct by the Contractor or Sub-Contractors or their personnel or offences under any other Law for the time being in force.
Transfer of Ownership	30.	30.1 Ownership of the Plant (including spare parts) to be imported into the country where the Site is located shall be transferred to the Employer upon loading on to the mode of transport to be used to convey the Plant from the country of origin to that country. 30.2 Ownership of the Plant (including spare parts) procured in the country where the Site is located shall be transferred to the Employer when the Plant are brought on to the Site. 30.3 Ownership of the Contractor's Equipment used by the Contractor and its Subcontractors in connection with the Contract shall remain with the Contractor or its Subcontractors. 30.4 Ownership of any Plant in excess of the requirements for the Facilities shall revert to the Contractor upon Completion of the Facilities or at such earlier time when the Employer and the Contractor agree that the Plant in question are no longer required for the Facilities. 30.5 Notwithstanding the transfer of ownership of the Plant, the responsibility for care and custody thereof together with the risk of loss or damage thereto shall

		remain with the Contractor pursuant to GCC Clause 31 (Care of Facilities) hereof until Completion of the Facilities or the part thereof in which such Plant are incorporated.
Care of Facilities	31	31.1 The Contractor shall be responsible for the care and custody of the Facilities or any part thereof until the date of Completion of the Facilities pursuant to GCC Clause 24 or, where the Contract provides for Completion of the Facilities in parts, until the date of Completion of the relevant part, and shall make good at its own cost any loss or damage that may occur to the Facilities or the relevant part thereof from any cause whatsoever during such period. The Contractor shall also be responsible for any loss or damage to the Facilities caused by the Contractor or its Subcontractors in the course of any work carried out, pursuant to GCC Clause 27. Notwithstanding the foregoing, the Contractor shall not be liable for any loss or damage to the Facilities or that part thereof caused by reason of any of the matters specified or referred to in paragraphs (a), (b) and (c) of GCC Subclauses 31.2 and 37.1. 31.2 If any loss or damage occurs to the Facilities or any part thereof or to the Contractor's temporary facilities by reason of (a) insofar as they relate to the country where the Site is located, nuclear reaction, nuclear radiation, radioactive contamination, pressure wave caused by aircraft or other aerial objects, or any other occurrences that an experienced contractor could not reasonably foresee, or if reasonably foreseeable could not reasonably make provision for or insure against, insofar as such risks are not normally insurable on the insurance market and are mentioned in the general exclusions of the policy of insurance, including War Risks and Political Risks, taken out under GCC Clause 33 hereof; or (b) any use or occupation by the Employer or any third party other than a Subcontractor, authorized by the Employer of any part of the Facilities; or (c) any use of or reliance upon any design, data, or specification provided or designated by or on behalf of the Employer, or any such matter for which the Contractor has disclaimed responsibility herein, the Employer shall pay to the Contractor all sums payable in respect of the Facilities executed, notwithstanding that the same be lost, destroyed, or damaged, and will pay to the Contractor the replacement value of all temporary facilities and all parts thereof lost, destroyed, or damaged. If the Employer requests the Contractor in writing to make good any loss or damage to the Facilities thereby occasioned, the Contractor shall make good the same at the cost of the Employer in accordance with GCC Clause 38. If the Employer does not request the Contractor in writing to make good any loss or damage to the Facilities thereby occasioned, the Employer shall either request a change in accordance with GCC Clause 39, excluding the performance of that part of the Facilities thereby lost, destroyed or damaged, or, where the loss or damage affects a substantial part of the Facilities, the Employer shall terminate the Contract pursuant to GCC Subclause 16 hereof. 31.3 The Contractor shall be liable for any loss of or damage to any Contractor's Equipment, or any other property of the Contractor used or intended to be used for purposes of the Facilities, except (i) as mentioned in GCC Subclause 31.2 with respect to the Contractor's temporary facilities, and (ii) where such

		loss or damage arises by reason of any of the matters specified in GCC Subclauses 31.2 (b) and (c) and 38.1. 31.4 With respect to any loss or damage caused to the Facilities or any part thereof or to the Contractor's Equipment by reason of any of the matters specified in GCC Subclause 37.1, the provisions of GCC Subclause 37.3 shall apply.
Loss of or Damage to Property; Accident or Injury to Workers; Indemnification	32	32.1 Subject to GCC Subclause 32.3, the Contractor shall indemnify and hold harmless the Employer and its employees and officers from and against any and all suits, actions, or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, in respect of the death or injury of any person or loss of or damage to any property other than the Facilities whether accepted or not, arising in connection with the supply and installation of the Facilities and by reason of the negligence of the Contractor or its Subcontractors, or their employees, officers, or agents, except any injury, death, or property damage caused by the negligence of the Employer, its contractors, employees, officers, or agents. 32.2 If any proceedings are brought or any claim is made against the Employer that might subject the Contractor to liability under GCC Subclause 32.1, the Employer shall promptly give the Contractor a notice thereof and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim. If the Contractor fails to notify the Employer within 28 days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the 28-day period, the Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim. The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing. 32.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers, and Subcontractors from any liability for loss of or damage to property of the Employer, other than the Facilities not yet taken over, that is caused by fire, explosion, or any other perils, in excess of the amount recoverable from insurances procured under GCC Clause 33, provided that such fire, explosion, or other perils were not caused by any act or failure of the Contractor. 32.4 The party entitled to the benefit of an indemnity under this GCC Clause 32 shall take all reasonable measures to mitigate any loss or damage which has occurred. If the party fails to take such measures, the other party's liabilities shall be correspondingly reduced.
Insurance	33	33.1 To the extent specified in the Appendix (Insurance Requirements) to the Contract Agreement, the Contractor shall at its expense take out and maintain

		in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified in the said Appendix. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, who should not unreasonably withhold such approval. (a) Cargo Insurance During Transport Covering loss or damage occurring while in transit from the Contractor's or Subcontractor's works or stores until arrival at the Site, to the Plant (including spare parts therefor) and to the Contractor's Equipment. (b) Installation All Risks Insurance Covering physical loss or damage to the Facilities at the Site, occurring prior to Completion of the Facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the Defect Liability Period while the Contractor is on the Site for the purpose of performing its obligations during the Defect Liability Period. (c) Third Party Liability Insurance Covering bodily injury or death suffered by third parties including the Employer's personnel, and loss of or damage to property occurring in connection with the supply and installation of the Facilities. (d) Automobile Liability Insurance Covering use of all vehicles used by the Contractor or its Subcontractors, whether or not owned by them, in connection with the execution of the Contract. (e) Workers' Compensation In accordance with the statutory requirements applicable in any country where the Contract or any part thereof is executed. (f) Employer's Liability In accordance with the statutory requirements applicable in any country where the Contract or any part thereof is executed. (g) Other Insurances Such other insurances as may be specifically agreed upon by the parties hereto as listed in the Appendix (Insurance Requirements) to the Contract Agreement. 33.2 The Employer shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to GCC Subclause 33.1, except for the Third Party Liability, Workers' Compensation, and Employer's Liability Insurances, and the Contractor's Subcontractors shall be named as co-insureds under all insurance policies taken out by the Contractor pursuant to GCC Subclause 33.1 except for the Cargo Insurance During Transport, Workers' Compensation, and Employer's Liability Insurances. All insurer's rights of

		subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies. 33.3 The Contractor shall, in accordance with the provisions of the Appendix (Insurance Requirements) to the Contract Agreement, deliver to the Employer certificates of insurance or copies of the insurance policies as evidence that the required policies are in full force and effect. The certificates shall provide that no less than 21 days' notice shall be given to the Employer by insurers prior to cancellation or material modification of a policy. 33.4 The Contractor shall ensure that, where applicable, its Subcontractor(s) shall take out and maintain in effect adequate insurance policies for their personnel and vehicles and for work executed by them under the Contract, unless such Subcontractors are covered by the policies taken out by the Contractor. 33.5 The Employer shall at its expense take out and maintain in effect during the performance of the Contract those insurances specified in the Appendix (Insurance Requirements) to the Contract Agreement, in the sums and with the deductibles and other conditions specified in the said Appendix. The Contractor and the Contractor's Subcontractors shall be named as co-insureds under all such policies. All insurers' rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies. The Employer shall deliver to the Contractor satisfactory evidence that the required insurances are in full force and effect. The policies shall provide that not less than 21 days' notice shall be given to the Contractor by all insurers prior to any cancellation or material modification of the policies. If so requested by the Contractor, the Employer shall provide copies of the policies taken out by the Employer under this GCC Subclause 33.5. 33.6 If the Contractor fails to take out and/or maintain in effect the insurances referred to in GCC Subclause 33.1, the Employer may take out and maintain in effect any such insurances and may from time to time deduct from any amount due the Contractor under the Contract any premium that the Employer shall have paid to the insurer, or may otherwise recover such amount as a debt due from the Contractor. If the Employer fails to take out and/or maintain in effect the insurances referred to in GCC 33.5, the Contractor may take out and maintain in effect any such insurances and may from time to time deduct from any amount due the Employer under the Contract any premium that the Contractor shall have paid to the insurer, or may otherwise recover such amount as a debt due from the Employer. If the Contractor fails to or is unable to take out and maintain in effect any such insurances, the Contractor shall nevertheless have no liability or responsibility towards the Employer, and the Contractor shall have full recourse against the Employer for any and all liabilities of the Employer herein. 33.7 Unless otherwise provided in the Contract, the Contractor shall prepare and conduct all and any claims made under the policies effected by it pursuant to this GCC Clause 33, and all monies payable by any insurers shall be paid to the Contractor. The Employer shall give to the Contractor all such reasonable assistance as may be required by the Contractor. With respect to insurance claims in which the Employer's interest is involved, the Contractor shall not

		give any release or make any compromise with the insurer without the prior written consent of the Employer. With respect to insurance claims in which the Contractor's interest is involved, the Employer shall not give any release or make any compromise with the insurer without the prior written consent of the Contractor.
Unforeseen Conditions	34.	34.1 If, during the execution of the Contract, the Contractor shall encounter on the Site any physical conditions other than climatic conditions, or artificial obstructions that could not have been reasonably foreseen prior to the date of the Contract Agreement by an experienced contractor on the basis of reasonable examination of the data relating to the Facilities including any data as to boring tests, provided by the Employer, and on the basis of information that it could have obtained from a visual inspection of the Site if access thereto was available, or other data readily available to it relating to the Facilities, and if the Contractor determines that it will in consequence of such conditions or obstructions incur additional cost and expense or require additional time to perform its obligations under the Contract that would not have been required if such physical conditions or artificial obstructions had not been encountered, the Contractor shall promptly, and before performing additional work or using additional Plant or Contractor's Equipment, notify the Project Manager in writing of (a) the physical conditions or artificial obstructions on the Site that could not have been reasonably foreseen; (b) the additional work and/or Plant and/or Contractor's Equipment required, including the steps which the Contractor will or proposes to take to overcome such conditions or obstructions; (c) the extent of the anticipated delay; and (d) the additional cost and expense that the Contractor is likely to incur. On receiving any notice from the Contractor under this GCC Subclause 34.1, the Project Manager shall promptly consult with the Employer and Contractor and decide upon the actions to be taken to overcome the physical conditions or artificial obstructions encountered. Following such consultations, the Project Manager shall instruct the Contractor, with a copy to the Employer, of the actions to be taken. 34.2 Any reasonable additional cost and expense incurred by the Contractor in following the instructions from the Project Manager to overcome such physical conditions or artificial obstructions referred to in GCC Subclause 34.1 shall be paid by the Employer to the Contractor as an addition to the Contract Price. 34.3 If the Contractor is delayed or impeded in the performance of the Contract because of any such physical conditions or artificial obstructions referred to in GCC Subclause 34.1, the Time for Completion shall be extended in accordance with GCC Clause 39.
Change in Laws and Regulations	35.	35.1 If, after the date 28 days prior to the date of Bid submission, in the country where the Site is located, any law, regulation, ordinance, order or by-law having the

		force of law is enacted, promulgated, abrogated, or changed, which shall be deemed to include any change in interpretation or application by the competent authorities, that subsequently affects the costs and expenses of the Contractor and/or the Time for Completion, the Contract Price shall be correspondingly increased or decreased, and/or the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been affected in the performance of any of its obligations under the Contract. Notwithstanding the foregoing, such additional or reduced costs shall not be separately paid or credited if the same has already been accounted for in the price adjustment provisions where applicable, in accordance with the SCC, pursuant to GCC Subclause 10
Force Majeure	36.	36.1 "Force Majeure" shall mean any event beyond the reasonable control of the Employer or of the Contractor, as the case may be, and which is unavoidable notwithstanding the reasonable care of the party affected, and shall include, without limitation, the following: (a) war, hostilities, or warlike operations whether a state of war be declared or not, invasion, act of foreign enemy and civil war; (b) rebellion, revolution, insurrection, mutiny, usurpation of civil or military government, conspiracy, riot, civil commotion, and terrorist acts; (c) confiscation, nationalization, mobilization, commandeering or requisition by or under the order of any government or de jure or de facto authority or ruler or any other act or failure to act of any local state or national government authority; (d) strike, sabotage, lockout, embargo, import restriction, port congestion, lack of usual means of public transportation and communication, industrial dispute, shipwreck, shortage or restriction of power supply, epidemics, quarantine, and plague; (e) earthquake, landslide, volcanic activity, fire, flood or inundation, tidal wave, typhoon or cyclone, hurricane, storm, lightning, or other inclement weather condition, nuclear, and pressure waves or other natural or physical disaster; and (f) shortage of labor, materials, or utilities where caused by circumstances that are themselves Force Majeure. 36.2 If either party is prevented, hindered, or delayed from or in performing any of its obligations under the Contract by an event of Force Majeure, then it shall notify the other in writing of the occurrence of such event and the circumstances thereof within 14 days after the occurrence of such event. 36.3 The party who has given such notice shall be excused from the performance or punctual performance of its obligations under the Contract for so long as the relevant event of Force Majeure continues and to the extent that such party's performance is prevented, hindered, or delayed. The Time for Completion shall be extended in accordance with GCC Clause 39. 36.4 The party or parties affected by the event of Force Majeure shall use reasonable efforts to mitigate the effect thereof upon its or their performance of the Contract and to fulfill its or their obligations under the Contract, but

		without prejudice to either party's right to terminate the Contract under GCC Subclauses 36.6 and 37.5. 36.5 No delay or nonperformance by either party hereto caused by the occurrence of any event of Force Majeure shall (a) constitute a default or breach of the Contract; or (b) give rise to any claim for damages or additional cost or expense occasioned thereby, subject to GCC Subclauses 31.2, 37.3 and 37.4 if and to the extent that such delay or nonperformance is caused by the occurrence of an event of Force Majeure. 36.6 If the performance of the Contract is substantially prevented, hindered, or delayed for a single period of more than 60 days or an aggregate period of more than 120 days on account of one or more events of Force Majeure during the currency of the Contract, the parties will attempt to develop a mutually satisfactory solution, failing which either party may terminate the Contract by giving a notice to the other, but without prejudice to either party's right to terminate the Contract under GCC Subclause 37.5. 36.7 In the event of termination pursuant to GCC Subclause 36.6, the rights and obligations of the Employer and the Contractor shall be as specified in GCC Subclauses 16 36.8 Notwithstanding GCC Subclause 36.5, Force Majeure shall not apply to any obligation of the Employer to make payments to the Contractor herein.
War Risks	37	37.1 "War Risks" shall mean any event specified in paragraphs (a) and (b) of GCC Subclause 36.1 and any explosion or impact of any mine, bomb, shell, grenade, or other projectile, missile, munitions or explosive of war, occurring or existing in or near the country (or countries) where the Site is located. 37.2 Notwithstanding anything contained in the Contract, the Contractor shall have no liability whatsoever for or with respect to (a) destruction of or damage to Facilities, Plant, or any part thereof; (b) destruction of or damage to property of the Employer or any third party; or (c) injury or loss of life if such destruction, damage, injury or loss of life is caused by any war risks, and the Employer shall indemnify and hold the Contractor harmless from and against any and all claims, liabilities, actions, lawsuits, damages, costs, charges, or expenses arising in consequence of or in connection with the same. 37.3 If the Facilities or any Plant or Contractor's Equipment or any other property of the Contractor used or intended to be used for the purposes of the Facilities shall sustain destruction or damage by reason of any war risks, the Employer shall pay the Contractor for

		(a) any part of the Facilities or the Plant so destroyed or damaged to the extent not already paid for by the Employer and so far as may be required by the Employer, and as may be necessary for completion of the Facilities; (b) replacing or making good any Contractor's Equipment or other property of the Contractor so destroyed or damaged; and (c) replacing or making good any such destruction or damage to the Facilities or the Plant or any part thereof. If the Employer does not require the Contractor to replace or make good any such destruction or damage to the Facilities, the Employer shall either request a change in accordance with GCC Clause 38 excluding the performance of that part of the Facilities thereby destroyed or damaged or, where the loss, destruction, or damage affects a substantial part of the Facilities, shall terminate the Contract, pursuant to GCC Subclause 16. If the Employer requires the Contractor to replace or make good on any such destruction or damage to the Facilities, the Time for Completion shall be extended in accordance with GCC 39 37.4 Notwithstanding anything contained in the Contract, the Employer shall pay the Contractor for any increased costs or incidentals to the execution of the Contract that are in any way attributable to, consequent on, resulting from, or in any way connected with any war risks, provided that the Contractor shall as soon as practicable notify the Employer in writing of any such increased cost. 37.5 If during the performance of the Contract any war risks shall occur that financially or otherwise materially affect the execution of the Contract by the Contractor, the Contractor shall use its reasonable efforts to execute the Contract with due and proper consideration given to the safety of its and its Subcontractors' personnel engaged in the work on the Facilities, provided, however, that if the execution of the work on the Facilities becomes impossible or is substantially prevented for a single period of more than sixty (60) days or an aggregate period of more than one hundred and twenty (120) days on account of any war risks, the parties will attempt to develop a mutually satisfactory solution, failing which either party may terminate the Contract by giving a notice to the other. 37.6 In the event of termination pursuant to GCC Subclauses 37.3 or 37.5, the rights and obligations of the Employer and the Contractor shall be specified in GCC Subclauses 16
Change in the Facilities	38.	38.1 <u>Introducing a Change</u> 38.1.1 Subject to GCC Subclauses 38.2.5 and 38.2.7, the Employer shall have the right to propose, and subsequently require, that the Project Manager order the Contractor from time to time during the performance of the Contract to make any change, modification, addition, or deletion to, in or from the Facilities hereinafter called "Change," provided that such Change falls within the general scope of the Facilities and does not constitute unrelated work and that it is technically practicable, taking into account both the state of advancement of the Facilities and the technical

		compatibility of the Change envisaged with the nature of the Facilities as specified in the Contract. 38.1.2 The Contractor may from time to time during its performance of the Contract propose to the Employer with a copy to the Project Manager, any Change that the Contractor considers necessary or desirable to improve the quality, efficiency, or safety of the Facilities. The Employer may at its discretion approve or reject any Change proposed by the Contractor, provided that the Employer shall approve any Change proposed by the Contractor to ensure the safety of the Facilities. 38.1.3 Notwithstanding GCC Subclauses 38.1.1 and 38.1.2, no change made necessary because of any default of the Contractor in the performance of its obligations under the Contract shall be deemed to be a Change, and such change shall not result in any adjustment of the Contract Price or the Time for Completion. 38.1.4 The procedure on how to proceed with and execute Changes is specified in GCC Subclauses 38.2 and 38.3, and further details and forms are provided in the Employer's Requirements (Forms and Procedures). 38.2 Changes Originating from Employer 38.2.1 If the Employer proposes a Change pursuant to GCC Subclause 38.1.1, it shall send to the Contractor a "Request for Change Proposal," requiring the Contractor to prepare and furnish to the Project Manager as soon as reasonably practicable a "Change Proposal," which shall include the following: (a) brief description of the Change, (b) effect on the Time for Completion, (c) estimated cost of the Change, (d) effect on Functional Guarantees (if any), (e) effect on the Facilities, and (f) effect on any other provisions of the Contract. 38.2.2 Prior to preparing and submitting the "Change Proposal," the Contractor shall submit to the Project Manager an "Estimate for Change Proposal," which shall be an estimate of the cost of preparing and submitting the Change Proposal. Upon receipt of the Contractor's Estimate for Change Proposal, the Employer shall do one of the following: (a) accept the Contractor's estimate with instructions to the Contractor to proceed with the preparation of the Change Proposal, (b) advise the Contractor of any part of its Estimate for Change Proposal that is unacceptable and request the Contractor to review its estimate (c) advise the Contractor that the Employer does not intend to proceed with the Change.

		38.2.3 Upon receipt of the Employer's instruction to proceed under GCC Subclause 38.2.2 (a), the Contractor shall, with proper expedition, proceed with the preparation of the Change Proposal, in accordance with GCC Subclause 38.2.1. 38.2.4 The pricing of any Change shall, as far as practicable, be calculated in accordance with the rates and prices included in the Contract. If such rates and prices are inequitable, the parties thereto shall agree on specific rates for the valuation of the Change. 38.2.5 If before or during the preparation of the Change Proposal it becomes apparent that the aggregate effect of compliance therewith and with all other Change Orders that have already become binding upon the Contractor under this GCC Clause 39 would be to increase or decrease the Contract Price as originally set forth in Article 2 (Contract Price) of the Contract Agreement by more than 15%, the Contractor may give a written notice of objection thereto prior to furnishing the Change Proposal as aforesaid.If the Employer accepts the Contractor's objection, the Employer shall withdraw the proposed Change and shall notify the Contractor in writing thereof. The Contractor's failure to so object shall neither affect its right to object to any subsequent requested Changes or Change Orders herein, nor affect its right to take into account, when making such subsequent objection, the percentage increase or decrease in the Contract Price that any Change not objected to by the Contractor represents. 38.2.6 Upon receipt of the Change Proposal, the Employer and the Contractor shall mutually agree upon all matters therein contained. Within 14 days after such agreement, the Employer shall, if it intends to proceed with the Change, issue the Contractor with a Change Order. If the Employer is unable to reach a decision within 14 days, it shall notify the Contractor with details of when the Contractor can expect a decision. If the Employer decides not to proceed with the Change for whatever reason, it shall, within the said period of 14 days, notify the Contractor accordingly. Under such circumstances, the Contractor shall be entitled to reimbursement of all costs reasonably incurred by it in the preparation of the Change Proposal, provided that these do not exceed the amount given by the Contractor in its Estimate for Change Proposal submitted in accordance with GCC Subclause 38.2.2. 38.2.7 If the Employer and the Contractor cannot reach agreement on the price for the Change, an equitable adjustment to the Time for Completion, or any other matters identified in the Change Proposal, the Employer may nevertheless instruct the Contractor to proceed with the Change by issue of a "Pending Agreement Change Order." Upon receipt of a Pending Agreement Change Order, the Contractor shall immediately proceed with effecting the Changes covered by such Order. The parties shall thereafter attempt to reach agreement on the outstanding issues under the Change Proposal.

		If the parties cannot reach agreement within 60 days from the date of issue of the Pending Agreement Change Order, then the matter may be referred to the Dispute Board in accordance with the provisions of Appendix – B, of the GCC 38.3 Changes Originating from Contractor 38.3.1 If the Contractor proposes a Change pursuant to GCC Subclause 38.1.2, the Contractor shall submit to the Project Manager a written "Application for Change Proposal," giving reasons for the proposed Change and including the information specified in GCC Subclause 38.2.1. Upon receipt of the Application for Change Proposal, the parties shall follow the procedures outlined in GCC Subclauses 38.2.6 and 38.2.7. However, should the Employer choose not to proceed, the Contractor shall not be entitled to recover the costs of preparing the Application for Change Proposal.
Extension of Time for Completion	39	39.1 The Time(s) for Completion specified in the SCC shall be extended if the Contractor is delayed or impeded in the performance of any of its obligations under the Contract by reason of any of the following: (a) any Change in the Facilities as provided in GCC Clause 38; (b) any occurrence of Force Majeure as provided in GCC Clause 36, unforeseen conditions as provided in GCC Clause 35, or other occurrence of any of the matters specified or referred to in paragraphs (a), (b) and (c) of GCC Subclause 31.2; (c) any suspension order given by the Employer under GCC Clause 41 hereof or reduction in the rate of progress pursuant to GCC Subclause 16 or (d) any changes in laws and regulations as provided in GCC Clause 35; or (e) any default or breach of the Contract by the Employer, or any activity, act or omission of the Employer, or the Project Manager, or any other contractors employed by the Employer; or (f) any other matter specifically mentioned in the Contract; or (g) any delay on the part of a sub-contractor, provided such delay is due to a cause for which the Contractor himself would have been entitled to an extension of time under this Subclause by such period as shall be fair and reasonable in all the circumstances and as shall fairly reflect the delay or impediment sustained by the Contractor. 39.2 Except where otherwise specifically provided in the Contract, the Contractor shall submit to the Project Manager a notice of a claim for an extension of the Time for Completion, together with particulars of the event or circumstance justifying such extension as soon as reasonably practicable after the commencement of such event or circumstance. As soon as reasonably practicable after receipt of such notice and supporting particulars of the claim, the Employer and the Contractor shall agree upon the period of such extension. In the event that the Contractor does not accept the Employer's estimate of a fair and reasonable time extension, the Contractor shall be

		entitled to refer the matter to a Dispute Board, pursuant to Appendix – B of the GCC. 39.3 The Contractor shall at all times use its reasonable efforts to minimize any delay in the performance of its obligations under the Contract. In all cases where the Contractor has given a notice of a claim for an extension of time under GCC 39.2, the Contractor shall consult with the Project Manager in order to determine the steps (if any) which can be taken to overcome or minimize the actual or anticipated delay. The Contractor shall there after comply with all reasonable instructions, which the Project Manager shall give in order to minimize such delay. If compliance with such instructions shall cause the Contractor to incur extra costs and the Contractor is entitled to an extension of time under GCC 39.1, the amount of such extra costs shall be added to the Contract Price.
Assignment	40.	40.1 Neither the Employer nor the Contractor shall, without the express prior written consent of the other party which consent shall not be unreasonably withheld, assign to any third party the Contract or any part thereof, or any right, benefit, obligation or interest therein or thereunder, except that the Contractor shall be entitled to assign either absolutely or by way of charge any monies due and payable to it or that may become due and payable to it under the Contract.
Contractor's Claims	41.	41.1 If the Contractor considers himself to be entitled to any extension of the Time for Completion and/or any additional payment, under any Clause of these Conditions or otherwise in connection with the Contract, the Contractor shall submit a notice to the Project Manager, describing the event or circumstance giving rise to the claim. The notice shall be given as soon as practicable, and not later than 28 days after the Contractor became aware, or should have become aware, of the event or circumstance. If the Contractor fails to give notice of a claim within such period of 28 days, the Time for Completion shall not be extended, the Contractor shall not be entitled to additional payment, and the Employer shall be discharged from all liability in connection with the claim. Otherwise, the following provisions of this Subclause shall apply. The Contractor shall also submit any other notices, which are required by the Contract, and supporting particulars for the claim, all as relevant to such event or circumstance. The Contractor shall keep such contemporary records as may be necessary to substantiate any claim, either on the Site or at another location acceptable to the Project Manager. Without admitting the Employer's liability, the Project Manager may, after receiving any notice under this Subclause, monitor the record keeping and/or instruct the Contractor to keep further contemporary records. The Contractor shall permit the Project Manager to inspect all these records, and shall (if instructed) submit copies to the Project Manager. Within 42 days after the Contractor became aware (or should have become aware) of the event or circumstance giving rise to the claim, or within such other period as may be proposed by the Contractor and approved by the Project Manager, the Contractor shall send to the Project Manager a fully detailed claim, which includes full supporting particulars of the basis of the claim and of the extension of time

		and/or additional payment claimed. If the event or circumstance giving rise to the claim has a continuing effect, (a) this fully detailed claim shall be considered as interim; (b) the Contractor shall send further interim claims at monthly intervals, giving the accumulated delay and/or amount claimed, and such further particulars as the Project Manager may reasonably require; and (c) the Contractor shall send a final claim within 28 days after the end of the effects resulting from the event or circumstance, or within such other period as may be proposed by the Contractor and approved by the Project Manager. Within 42 days after receiving a claim or any further particulars supporting a previous claim, or within such other period as may be proposed by the Project Manager and approved by the Contractor, the Project Manager shall respond with approval, or with disapproval and detailed comments. He may also request any necessary further particulars, but shall nevertheless give his response on the principles of the claim within such time. Each payment certificate shall include such amounts for any claim as have been reasonably substantiated as due under the relevant provision of the Contract. Unless and until the particulars supplied are sufficient to substantiate the whole of the claim, the Contractor shall only be entitled to payment for such part of the claim as he has been able to substantiate. The Project Manager shall agree with the Contractor or estimate: (i) the extension (if any) of the Time for Completion (before or after its expiry) in accordance with GCC Clause 40, and/or (ii) the additional payment (if any) to which the Contractor is entitled under the Contract. The requirements of this Subclause are in addition to those of any other Subclause, which may apply to a claim. If the Contractor fails to comply with this or another Subclause in relation to any claim, any extension of time and/or additional payment shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the claim, unless the claim is excluded under the second paragraph of this Subclause. In the event that the Contractor and the Employer cannot agree on any matter relating to a claim, either party may refer the matter to the Dispute Board pursuant to Appendix – B. hereof.

APPENDIX A

General Conditions for admissibility of Escalation

1. The exact percentage of labour/ material (excluding materials to be supplied by the Procuring Entity)/ bitumen/ diesel and petrol/ cement/ steel component for the Works shall be approved by the authority while sanctioning the detailed Estimates.

2. The breakup of components of labour/ materials (excluding materials to be supplied by the Procuring Entity)/ bitumen/ diesel and petrol/ cement/ steel as indicated in this Clause have been pre-determined as below:-

   (a) Labour ---------- 30 percent

   (b) Material ---------- 50 percent

   (c) Bitumen ---------- 01 percent

   (d) Diesel and Petrol ---------- 01 percent

   (e) Cement ---------- 12 percent

   (f) Steel ---------- 06 percent

   Total----------100%]

3. While allowing price escalation the following shall be deducted from the value of Works done (R):

   (a) Cost of material supplied by the Procuring Entity.

   (b) Cost of services rendered for protection of the Works.

   (c) Secured Advance/ any advance added earlier but deducted now after Works is measured.

   (d) Cost of extra items, the rates for which have been worked out based on market rates/ mutually agreed rates.

4. The first statement of escalation shall be prepared at the end of three months in which the Works was awarded and the Works done from the date of start to the end of this period shall be taken into account. For subsequent statement, cost of Works done during every quarter shall be taken into account. At the completion of Works, the Works done during the last quarter or fraction, thereof, shall be taken into account.

5. For the purpose of reckoning the Works done during any period, the bills prepared during the period shall be considered. The dates of recording measurements in the Measurement Book by the Assistant Engineer shall be the guiding factor to decide the bills relevant to any period. The date of completion, as finally recorded by the competent authority in the Measurement Book, shall be the criterion.

6. The index relevant to any quarter, for which such compensation is paid, shall be the arithmetical average of the indices relevant of the calendar month.

7. Price adjustment Clause shall be applicable only for the Works that is carried out within the stipulated time, or extension thereof, as are not attributable to the Contractor.

8. If during the progress in respect of Contract Works stipulated to cost Rs.50 lacs or less, the value of Works actually done excluding cost of material supplied by the Procuring Entity, exceeds Rs. 50 lacs and completion period is more than 3 months, then escalation would be payable only in respect of value of Works in excess over Rs.50 lacs from the date of satisfying both the conditions.

9. Where originally stipulated period is 3 months or less but actual period of execution exceeds beyond 3 months on account of reasons not attributable to the Contractor, escalation amount would be payable only in respect of extended period if amount of Works is more than Rs.50 lacs.

10. In case the Contractor does not make prorata progress in the first or another time span and the short fall in progress is covered up by him during subsequent time span within original stipulated period then the price escalation of such Works expected to be done in the previous time span shall be notionally given based upon the price index of that quarter in which such Works was required to be done.

11. No claims for price adjustment other than those provided herein, shall be entertained.

12. If the period of completion including extended period attributable to the Procuring Entity exceeds three months but cost does not exceeds more than Rs.50 lacs, no escalation is admissible.

13. Similarly, if cost of Works increases more than Rs.50 lacs but completion period including extended period attributable to the Procuring Entity is less than 3 months, no escalation is admissible.

14. No provisional escalation is payable on the basis of indices of the previous quarter in absence of non publication of indices for concerned quarter by the RBI.

15. Escalation is always payable quarterly and no provisional escalation is payable monthly or fortnightly.

16. In case at the time of executing agreement, both the conditions (completion period 3 months and amount of Works Rs.50 lacs for admissibility of price escalation are not fulfilled and subsequent due to additional Works and extension of time attributable to Procuring Entity, both the conditions become fulfilled, in that case the escalation shall be payable from the date of satisfying both the conditions and only for Works done beyond Rs.50 lacs and in period of Works beyond 3 months.

17. The Contractor shall for the purpose of these conditions 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 the Government/ Procuring Entity and further shall at the request of the Engineer-in-charge furnish, verified in such a manner as the Engineer-in-charge may require any documents so kept and such other information as the Engineer-in-charge may require.

18. Price variation Clause shall be applicable in case of lump sum contracts estimated to cost more than Rs.100 crores with stipulated completion period of more than 18 months.

19. The component of operation and maintenance (O&M) cost included in the Contract Price shall not be subject to price variations. The price may be adjusted by the use of prescribed formula (or formulae) which breaks down the total price into components.

20. The amount of price variation in case of lump sum contracts will be made by adding or deducting, as the case may be, from the payments made at the stages of Works specified in the Contract document.

Appendix B
Dispute Resolution During Execution of the Contract

1.0 Dispute

Disputes are germane to any contract. A 'dispute' implies an assertion of a right or a claim by one party and repudiation thereof by the other party, either expressed or implied, and may be by words or by conduct. A mere 'difference' is not necessarily a dispute; when the parties fail to resolve it, the difference culminates in dispute.

1.1 Dispute Resolution in a Construction Contract

Since arbitrations are fairly time consuming, it is always advisable to sort out the disputes mutually through the mechanism of adjudication through Dispute Resolution Board (DRB), which is a sort of voluntary arbitration. Arbitration can be resorted to if the adjudication decision is not forthcoming or is not acceptable to any party. For dispute resolution following procedure will be followed:

2.0 Dispute Resolution Board (DRB)

(a) A formal Sub-Clause of obtaining dispute resolution through DRB will be inserted in the Conditions of the Contract. A separate Dispute Resolution Agreement will also be drawn up, detailing therein provisions like: Eligibility of Members, date of commencement, manner of entry on the reference by the Members and their resignation; obligation of the Members, the Procuring Entity and the Contractor; terms of payment (monthly retainership fee, daily fee for travel & site visits, out-of-pocket expenses); manner of sharing the fees and expenses and of making payments; arrangements of site visits and their frequency; conduct of hearings; termination/ phasing out the activities of DRB; default of the Member, and action to be taken in case of dispute in relation to DRB Agreement, etc.

(b) DRB should be put in place within one month of Letter of Acceptance.

(c) The DRB for all projects costing more than Rs 10 crore will comprise of three Members, one each to be appointed by the Procuring Entity and the Contractor and approved by the other. The third Member, who will also act as the presiding Member, will be selected by the first two Members and approved by the parties. If either of the first two Members is not so selected and approved, or the parties fail to reach an agreement on the third Member then on request of either or both parties, appointment will be made by concerned Administrative Department in case of Government Departments and Head of the Organisation (Chairman, etc.) concerned in other cases.

(d) The Members to be appointed shall be out of a panel maintained by the Department/ Organisation concerned and should be experienced in the type of construction actually involved and/ or finance and accounts and/ or contractual documents. **They should be persons ofrepute and integrity**.

(e) If any dispute that arises at any stage between the Procuring Entity and the Contractor in connection with, or arising out of the Contract or the execution of the Works, including any disagreement by either party with any action, inaction, opinion, instruction, determination, certificate or valuation of the Engineer, the matter in dispute shall, in the first place, should be tried to be settled amicably. If the dispute still remains unsettled, it shall be referred to the DRB.

(f) Both parties shall promptly make available all information, access to the Site, and appropriate facilities, as the DRB may require for the purposes of making a recommendation on such dispute.

(g) Within 56 days after receiving such reference, or within such other period as may be proposed by the DRB and approved by both parties, the DRB shall give its recommendation with reasons. The recommendation shall be binding on both parties, who shall promptly give effect to it unless and

until it shall be revised in an amicable settlement or an arbitral award as described below. Unless the Contract has already been abandoned, repudiated or terminated, the Contractor shall continue to proceed with the Works in accordance with the Contract.

(h) If either party is dissatisfied with the recommendation, then either party may, within 28 days after receiving the recommendation, or if the DRB fails to give its recommendation within 56 days (or as otherwise approved), within 28 days after the said period of 56 days has expired, give notice to the other party, with a copy to the Engineer-in-Charge, of its intention to commence arbitration proceedings.

(i) If the DRB has given its decision within the stipulated period, and no notice of intention to commence arbitration as to such dispute has been given by either party within 28 days of the said decision, then the decision of DRB shall become final and binding.

3.0 Arbitration

(a) Any dispute in respect of which the recommendations (if any) of DRB has not become final and binding, shall be finally settled by arbitration in accordance with the Indian' Arbitration and Conciliation Act, 1996, or any statutory amendment thereof.

(b) The Arbitral Tribunal will comprise three Members, one each to be appointed by the Procuring Entity and the Contractor. The third Member, who will also act as the presiding Member, will be appointed by mutual consent of the first two Members. If the parties fail to reach an agreement on the third Member then on request of either or both parties, appointment will be made by concerned Administrative Department in case of Government Departments and Head of the Organisation (Chairman, etc.) concerned in other cases.

(c) The Tribunal shall have full power to open up, review and revise any certificate, determination, instruction, opinion or valuation of the Engineer-in-Charge, and any decision of the DRB, relevant to the dispute.

(d) Neither party shall be limited in the proceedings before the Tribunal to the evidence or arguments previously put before the DRB to obtain its decision, or to the reasons for dissatisfaction given in its notice of dissatisfaction.

(e) Arbitration may be commenced prior to or after completion of the Works. The obligations of the Parties, the Engineer-in-Charge and the DRB shall not be altered by reason of any arbitration being conducted during the progress of the Works.

4.0 Language

All proceedings before DRB/ arbitral tribunal shall be in the Language of the Contract/ English.

5.0 Terms and conditions for engagement of DRB Member and Chairman

The terms and conditions including the remuneration and other facilities to be given to the Members of DRB and Arbitrators in case of civil engineering construction contracts/ consultancies shall be as notified by the State Government from time to time. Each Party to the Contract (the Contractor/ Consultant) shall be responsible for paying one-half of the remuneration. Since the fee structure has to be agreed by both the parties i.e. Procuring Entity and Contractor/ Consultant, the fee structure may also be got accepted by the respective Contractor/ Consultants. In the contracts the fee structure may be included as part of the bidding documents/ contract documents and the acceptance of the fee structure by the Contractors/ Consultants may be kept as a pre-condition for signing the Contract.

Note: Appendix-B shall be applicable only after the approval from USCL.

Section-VIB : Special Conditions of the Contract/ Contract

Section VI B: Contract Data / Special Conditions of Contract

Ref. to GCC	Subject	Data
1.1	Procuring Entity's designation and address are:	**THE CHIEF EXECUTIVE OFFICER** **Udaipur Smart City Limited.** **EMAIL: mc_udaipur@rediffmail.com**
	The Works or Work is:	**Udaipur Integrated Infrastructure Project**
	The Site is:	As detailed in Section V of the Bid document
	Engineer-in-Charge's Designation and Address and communication details are:	**Er. Arun Vyas,** **Superintending Engineer (SE),** **Udaipur Smart City Limited,** **Municipal Corporation of Udipur,** **Town Hall, Udaipur – 313001, Rajsthan**
	The Time for Completion and the Intended Completion Date are:	**Twenty – Four (24) months - Design (6 Months) and Execution (18 Months)** followed by **Operation and Maintenance** of **Ten (10) Yeats,** including Defect Liability Period (DLP) of One (1) Year - (for the complete work, consisting of Six (6) components). Partial Completion of the subject contract will not be admissible.
	Provisional sums/ Lump sums are:	Item rate as specified in Clause 1.1.3 of Section-II: Bidding Data Sheet (BDS).
	The Department is:	**Udaipur Smart City Limited (USCL)**
1.31.1 .12.3	Scope of Facilities	The contractor will be responsible for Operation and Maintenance of the facilities created for a period of Ten (10) years starting from issuance of Completion Certificate. The price quoted by bidder for O&M phase activities will include cost of all essential spare parts, for the entire duration of the O&M phase. The details of quantity, specification and cost of the spare parts included in the Price Bid will have to be provided separately using addition sheets.
1.3	Communication:	Electronic transmission shall include e-mail, fax etc. and delivered shall include their transmission sent successfully to correct address, as mentioned above Clause 1.1
1.4	The Language of the Contract is:	English
1.4.8	Provisional Sum	A Provisional Sum (PS) is mentioned in the Price Bid BoQ, Item 4.11, Section IV Bidding Forms of this bid document. The Procuring Entity may decide to utilise the PS for any such expenditure (e.g. Third Party Inspection etc.) as the Procuring Entity may decide at their sole discretion, during any point in time during the contract period
1.8.1	Signing of the Contract Agreement:	Within 30 Days of issue of notification of the award. Add following text; It is mandatory to register the JV under relevant Act after award of Letter of Acceptance but before signing of Contract Agreement within 30 days of issuance of Letter of Acceptance.

		Failure to register the JV in stipulated period may lead to forfeiture of bid security. The equity sharing as declared at the time of bidding shall be maintained while registering the JV before Contract execution. The minimum equities of all partners shall be maintained throughout the currency of contract. The Contract Agreement shall be executed with authorized representative of JV and all partners of JV.
1.14	Care and Supply of documents	Add: The Contractor shall maintain standard Site Order Books at the Site at all times during the execution of the Works for the use of the Procuring Entity's Representative and the Contractor. All instructions issued by the Procuring Entity's Representatives to the Contractor shall be recorded in duplicate in the Site Order Book and shall be signed by the issuer and countersigned by the Contractor. After compliance with the instruction the Contractor shall record the same in the Site Order Book duly signed and countersigned by the Procuring Entity's Representative. Acceptance of any part of the Works executed by the Contractor shall be subject to verification with respect to compliance of respective instructions of the Procuring Entity's Representative through the Site Order Book. The Procuring Entity's Representative shall retain the original copy of the site orders, while the Contractor shall retain the duplicate ones.
4.1.5	Requirement of designing by the Contractor:	The scope to carry out designs & drawings are as specified in Section V of the document, Work Requirements. And shall be approved by EIC.
4.3.1	Performance Security	**Replace GCC Clause 4.3.1 (i) with the following**: The bidder has to submit Two (2) sets of Performance Securities. **Design & Execution Phase:** Performance Security amounting to 10% of the contract value for works of the Design & Execution Phase shall be submitted in advance at the time of signing of agreement in form of BG. If the bidder fails to deposit the Performance Security within the stipulated time frame the Bid Security will be forfeited. **Operation and Maintenance (O&M) Phase:** Performance Security amounting to 10% of the contract value of the O&M Phase shall be submitted in advance before submitting the final bill/ completion of project in form of BG. If the bidder fails to deposit the Performance Security within the stipulated time frame the Performance Security of the Design & Execution Phase will not be released. The BG should be issued by any nationalized / schedule bank and shall remain valid up to 60 days beyond defect liability period. Bank Guarantee submitted against the performance guarantee, shall be unconditional and encashable/invokable at Udaipur when presented in specified Branch Office.

4.3.5	Refund of Performance Security	**Replace GCC Clause 4.3.5 with the following:** The Procuring Entity shall return or release the Performance Security to the Contractor as given below after completion of all obligations under the Contract, more specifically, after the expiry of the period as specified below: **Construction Phase: Performance Security**, shall be refunded within 60 days after the satisfactory completion of the Defect Liability Period, subject to completion of all obligations under the Contract. **O&M Phase: Performance Security**, shall be refunded within 60 days after the satisfactory completion of all obligations for the phase under the Contract.
4.4	Commencement of the Works	The Works shall be commenced within a period of 7 Days from the date of signing of the Contract or handing over of the site by the Employer, whichever is later..
4.14	Avoidance of Interference with public conveniences	Add, In case any operation connected with the works necessitates diversion, obstruction or closure of any road, railway, waterway or any other right of way, the approval of the Engineer-in-charge or the Engineer's Representative and the respective competent authorities shall be obtained well in advance by the Contractor. In case the Contractor's operations obstruct access to adjacent properties, the Contractor shall be responsible to provide reasonable temporary access to the affected parties. In case the Contractor fails to provide adequate temporary facilities, this shall be deemed to be an uncorrected Defect under the terms of Clause 13 and the Procuring Entity shall have the right to engage a third party to correct the Defect and the cost of such correction will be deducted from the Contract Price. The contractor will also be responsible to ensure completion of his work with utmost effort in earliest possible period to ensure minimum inconvenience to the public at large. If in the opinion of the Engineer in Charge, the work has not been done in time and the passage way not restored satisfactorily in time, he may after giving a notice of seven days have the work done through any other agency. He will in these circumstances enter the work done as work done by the contractor in measurement book and pay for the same to the contractor and also recover the actual cost paid by him for the work plus 5% of the value of this work from the payments or any other money due to the contractor.
4.18	Cost of water & electricity	Add: Charges for power connection and water, if required, for trial run and commissioning of the facility, shall be borne by contractor
5	Norms related to NBC	That anything and everything to do with built environment must be in accordance with the newly released National Building Code of India 2016 (part 3, section 13)
6.5	Safety Norms	**Add Sub Clause 6.5.1 as follows:** The Contractor has to:

		(a) Prepare a detailed Safety Plan, to be implemented under supervision of Safety Officer of the Contractor, within **28** (twenty eight) days of receiving of Letter of Acceptance to be approved by the Engineer-in-Charge. (b) Provide for all safety measures, security and protection of equipment as provided in the Clause and shall be paid as per relevant items in the Bill of Quantities. Any item not covered in the Bill of Quantities shall be deemed to have been included in the bidders quoted rates.
6.7	The normal working hours at the Site and Days of rest shall be:	9 AM to 5 PM as per relevant Labour Laws. However, when work is stopped, it should be ensured by the contractor that all safety measures have been taken to avoid any untoward incident during non-working hours.
7.18	Royalties	The contractor will provide documented evidence of payment of Royalties, Rent and Octroi and all other payment, as stipulated by the laws of the state of Rajasthan, with each invoice raised per month.
7.3	Inspection	Add: The Contractor shall place order for the material and the equipment only after approval of the Engineer-in-charge. The Contractor shall submit the detailed drawings, if any, to the Engineer-in-charge for approval. For Equipment: The Contractor shall inform the Engineer-in-charge about the likely dates of testing and dispatching of the material. The Contractor shall notify the Engineer-in-charge for inspection and testing, at least seven (7) days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates. The inspection and test categories shall be applied prior to delivery of the equipment, of various categories as indicated in the technical specifications for each type of equipment. **Category A**: The drawing has to be approved by the Procuring Entity's Representative before manufacture and testing. The material has to be inspected by the Engineer-in-charge or an inspecting agency after approval of Procuring Entity's Representative at the manufacturer's premise before packing and dispatching. The inspection charges of the agency will be borne by the Procuring Entity but the contractor has to pay the inspection charges. The contractor will include in their next bill the inspection charges and the same will be reimbursed by the Procuring Entity from the provisional sum. The contractor shall provide the necessary equipment and facilities for tests and the cost thereof shall be borne by the Contractor. **Category B**: The drawings of the equipment have to be submitted and to be approved by the Engineer-in-charge prior to manufacture. The material has to be tested by the manufacturer and the manufacturer's test certificates are to be submitted and approved by the Engineer-in-charge before

		dispatching of the equipment. Notwithstanding the above, the Engineer-in-charge, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of the Contractor's representative. **Category C:** The material may be manufactured as per relevant standards and delivered to the site. For material / equipment under Category 'A' and 'B' the Engineer-in-charge will provide an\ authorization for packing and shipping after inspection.
8.4	**Time for Completion**	The Time for Completion of the whole of the Facilities shall be **Twelve (12) Years** from the Effective Date as described in the Contract Agreement. Add the following clause: Time for Completion for parts of the Facilities: are given below: a) **Execution** period – **Twenty Four (24) months**, including Six (6) months of Design period **b) Operation and Maintenance** period of **One Hundred and Twenty (120) months**, including **Defect Liability Period**
8.5	Construction Program	The Contractor shall submit for approval a Program for the Works within 21 days from the date of the Letter of Acceptance. The period between Program updates is **30** days. The amount to be withheld for late submission of an updated Program is **INR 50,000.**
10.3	General Conditions for admissibility of Price Variation	Payment against price variation shall not be admissible in this contract.
13.1	Defect Liability Period	The Defects Liability Period is: **365** days.
15.3	Schedule of Payments *(in case of Lump Sum Contract payments shall be linked to various stages of completion of Works given in the Activity Schedule)*	Add: **Design Period (Six Months):** After approval of the Detailed Engineering Design of each component, payment will be released as per the Price quoted by the Contractor and agreed to by the employer, as detailed in the Contract Agreement, for the item of work. **Construction period (Eighteen Months):** This being an Admeasurement contract, the selected contractor will raise monthly invoices, against the work done in the preceding month and will be paid accordingly after deductions, if any, as per the contract condition. **Operation and Maintenance Period (Ten Years):** The selected contractor will raise monthly invoices, and will be paid accordingly after deductions, if any, as per the contract condition. **Penalty:** **A Water Supply Component:** For non-compliance with the water quality parameter, during the **Operation and Maintenance Period of Ten (10) years**, 1. Residual chlorine at outlet of WTP substation installations is found less than 2 ppm, a penalty of Rs. 5000/- per event per day shall be levied

		2. PF is not maintained at all times between 0.90 to 1.0 at Intake or any of the physico-chemical and biological parameters, as mentioned in the Section VA of this document, is found in the beyond acceptable range as specified in IS: 10500., a penalty of Rs. 5000/- per event per day shall be levied 3. In case the downtime in a day for the WTP exceeds 06 hours at a stretch, the contractor will be penalised Rs.5000 / hour (Rupees five thousand per hour only, for each hour. exceeding the limit of 06 hours. 4. Further if this downtime exceeding 06 hours takes place more than on 3 no. Occasion in a month a penalty of Rs 10000/-(Rupees ten thousand per event only) will be imposed. 5. In case the Contractor fails to supply and /or Install AMR meters against quarterly targets as committed by the contractor a penalty will be levied on pro-rata basis on the cost of meters short supplied subject to maximum of 10% of contract value. 6. Non submission of monthly report shall invite penalty of INR 10,000 for each such occurrence. 7. The defective meters, if any will be removed and New tested meter would be installed immediately within 3 days after intimation by Employer. However, the upper limit should not be more than seven days failing which a penalty of Rs 10,000/ per day will be levied for each day exceeding 7 days 8. In case any Child labour is employed at site in violation with the laws of the state and India, the employer will levy an additional penalty of Rs 25,000 per incidence and in such instance occurs more than once the contract may be terminated, to be decided at the sole discretion of the Employer **B Sewerage Component:** For non-compliance with the following parameter/issues, during the **Operation and Maintenance Period of Ten (10) years**, 9. No leaks / blockages in pipes, joints, locations of specials and valves - Penalty for non-compliance will be INR 10,000 per instance. 10. No overflows from the Manholes, LS & MWPS - Penalty for non-compliance will be INR 10,000 per instance 11. All valves are properly installed and operational - Penalty for non-compliance will be INR 10,000 per instance 12. Submission of “As built” drawings both in soft copies and hard copies (two prints and one polyester film) - Penalty for non-compliance will be INR 50,000 13. Operation of all locking arrangements of valve chambers, cover opening smooth and locks in place - Penalty for non-compliance will be INR 5,000 per instance.

		14. Silt removed from the sewerage system should be removed by next day from the road side - Penalty for non-compliance will be INR 20,000 per instance. 15. CCTV inspection to be carried out after removal of silt from the system and submitted to the Employer within a week - Penalty for non-compliance will be INR 10,00 per instance 16. The Contractor shall submit a weekly report to the Employer detailing the Operation and Maintenance indicating the labour hours expended and other Consumables consumed and also problems faced and rectified - Penalty for non-compliance will be INR 10,000 per instance 17. During the Operation and Maintenance period, the Contractor shall ensure that the sewage detention time in wet well not exceeds 30 min. and there is no backflow of sewage. The Contractor is responsible for maintaining back up power arrangements at his cost to ensure that the O&M services are not affected due to failure of power supply from the Public Utility Company - Penalty for non-compliance will be INR 10,000 per instance. 18. Minimum time for rectification 19. Blockage and overflows - 12hours - Penalty for non-compliance will be INR 10,000 per instance 20. Stolen / Broken man hole covers - 12hours - Penalty for non-compliance will be INR 10,000 per instance 21. Sewer spills from main sewer, branch and house service connections (between property chamber and public - 72hours - Penalty for non-compliance will be INR 10,000 per instance 22. Record all complaints received regarding sewer blockage and clearance with same date and time - Penalty for non-compliance will be INR 10,000 per instance 23. Record condition of sewer found at the time of attending complaint. Damage notice should be recorded by attending staff - Penalty for non-compliance will be INR 10,000 per instance 24. The Contractor shall carry out mandatory biannual cleaning of network before and after the monsoon season including cleaning of all manhole chambers and collection network irrespective of the regular maintenance work - Penalty for non-compliance will be INR 10,000 per instance. 25. identification and reporting of illegal connections on the sewerage network as soon as these are detected - Penalty for non-compliance will be INR 10,000 per instance. 26. Non submission of monthly report shall invite penalty of INR 10,000 for each such occurrence. 27. In case any Child labour is employed at site in violation with the laws of the state and India, the employer will levy an additional penalty of Rs 25,000 per incidence and in such instance occurs more than once the contract may be terminated, to be decided at the sole discretion of the Employer

		C Electrical Component: For non-compliance with the following parameter/issues, during the **Operation and Maintenance Period of Ten (10) years**, 28. Non submission of monthly report shall invite penalty of INR 10,000 for each such occurrence. 29. In case any Child labour is employed at site in violation with the laws of the state and India, the employer will levy an additional penalty of Rs 25,000 per incidence and in such instance occurs more than once the contract may be terminated, to be decided at the sole discretion of the Employer **D SCADA Component:** For non-compliance with the following parameter/issues, during the **Operation and Maintenance Period of Ten (10) years**, *1. **Computer Start Up*** Total time for the start-up of a computer, including automatic program load, initialization and database updating, shall not exceed five minutes for critical functions (SCADA, front-ends servers). Automatic restart following a power outage shall also not exceed five minutes. 2. Complete SCADA functionality: shall be available within a further five minutes following a start-up or automatic restart of the last computer in the minimum set of computers required to be running to support this functionality. Updates from field devices may extend beyond this time but the full update of the System with data from the field shall not exceed a further five minutes. Thus, a complete restart of the System, including full update from the field, shall not exceed 15 minutes. **3. SCADA System must have System availability of 99.9 %.** A minimum Penalty @ INR 10,000.00 will be levied per incidence of non-compliance with point 1, 2 and @ INR 50,000.00 for compliance with point 3, respectively, which may be increased by the Procuring Entity.
20	Insurance	The details of Insurance covers to be obtained by the Contractor and the Procuring Entity, including their value, terms and extent of coverage and other terms and conditions shall be as under: (a) for the Works, Plant and Materials; (b) for loss or damages to equipment; (c) for loss or damage to property (except the Works, Plant, Materials and Equipment) in connection with Contract; (d) for personal injury or death; (i) of the Contractor's employees; (ii) of other people The Sum Insured against each of these items will be as per the Laws of the state of Rajasthan. **For Road and Drainage component:** The minimum amount of Third Party Liability insurance cover shall be Rs

		10,00,000(Rupees ten Lakhs only) per occurrence or event, with the number of occurrences not less than four. The Contractor shall promptly notify the Engineer-in-Charge of each claim made under the Third Party Liability coverage, and shall renew the Third Party Insurance after each such occurrence in order to maintain the number of covered occurrences at not less than four. The minimum coverage against damage to the Works and materials during construction shall be Rs. 5,00,000 (Rupees Five Lakhs only).
22.2	**Labor**	22.2.5 **Working Hours** (a) Normal working hours are: **Eight** 22.2.7 **Health and Safety** (d) The Contractor shall throughout the contract (including the Defect Liability Period): (i) conduct Information, Education and Consultation Communication (IEC) campaigns, at least every other month, addressed to all the Site staff and labor (including all the Contractor's employees, all Sub-Contractors and Employer's and Project Manager's employees, and all truck drivers and crew making deliveries to Site for construction activities) and to the immediate local communities, concerning the risks, dangers and impact, and appropriate avoidance behavior with respect to of Sexually Transmitted Diseases (STD)—or Sexually Transmitted Infections (STI) in general and HIV/AIDS in particular; (ii) provide male or female condoms for all Site staff and labor as appropriate; and (iii) provide for STI and HIV/AIDS screening, diagnosis, counseling and referral to a dedicated national STI and HIV/AIDS program, (unless otherwise agreed) of all Site staff and labor. The Contractor shall include in the program to be submitted for the execution of the Facilities under Subclause 18.2 an alleviation program for Site staff and labor and their families in respect of Sexually Transmitted Infections (STI) and Sexually Transmitted Diseases (STD) including HIV/AIDS. The STI, STD and HIV/AIDS alleviation program shall indicate when, how and at what cost the Contractor plans to satisfy the requirements of this Subclause and the related specification. For each component, the program shall detail the resources to be provided or utilized and any related sub-contracting proposed.

		The program shall also include provision of a detailed cost estimate with supporting documentation. Payment to the Contractor for the preparation and implementation this program shall not exceed the amount dedicated for this purpose.
25	**Commissioning and Operational Acceptance**	25.2.2 The Guarantee Test of the Facilities shall be successfully completed within .Twenty-eight (28) days from the date of Completion
26	**Completion Time Guarantee**	26.3 No bonus will be given for earlier Completion of the Facilities or part thereof.
29 b)	**Limitation of Liability**	The multiplier of the Contract Price is: **1.1**

Special Condition of Contract (For Water Supply PART-"A")

Definitions

"Department" means the Udaipur Smart City Limited (USCL) as the Executing Agency of the Project.

"Materials" means things of all kinds (other than equipment) intended to form or forming part of the permanent works, including the supply of materials to be supplied by the contractor under the contract.

"Equipment" means the apparatus, machinery, articles and things of all kinds to be provided under the contract or intended to form or forming part of the permanent works.

"Contractor's Documents" means the calculations, computer programs and other software, drawings, manuals, models and other documents of the technical nature supplied by the contractor under the contract; as described in sub clause 9.2 [Contractors Documents].

"Specifications" means the specifications according to which the works are to be executed as referred to in the agreement documents and any other specifications agreed thereon.

"Contract price" means the sum quoted in the tender subject to such additions thereto or deduction there from as may be made under the provisions contained in the contract or as due to change in scope of work for pipeline &b reservoirs as defined in Volume IV of tender Document.

Communication between the USCL & Contractor

Addresses for notices

Notices with legal and contractual issues shall be addressed to the "**CEO, USCL, Udaipur**"or any changed address". Notices with technical issues shall be addressed to the respective Engineer (s) in Charge and copy to

1. Superintending Engineer, Executive Engineer, USCL, **Udaipur .**

Any notice given by the Contractor to the **CEO, USCL** or the Engineer in Charge under the terms of the Contract shall be sent by post, courier, cable, telex, or fax to or left at the office of the Chief Executive Officer, USCL or the Engineer in Charge only or the addresses as shall be indicated for this purpose only.

All certificates, notices or instructions to be given to the Contractor by the **CEO, USCL** or the Engineer in Charge under the terms of the Contract shall be sent by post, courier, cable, telex, or fax to or left at the Contractor's principal address or the addresses as the Contractor shall indicate for this purpose only.

It shall be essential for the contractor to obtain a receipt of authorised officer otherwise the notice shall be treated as "null & void".

3.3 CONTRACT

3.3.1 Type of Contract

The contractor shall execute work for ***"*Integrated Infrastructure Package for ABD area with 10 years Operation & Maintenance including 01 year defect liability period i.e. design(Selected Part), Build, Operate and Maintenance**." as described in this tender document.

3.3.2 Priority of contract

The documents forming part of the agreement are to be taken as mutually explanatory documents of one another. In case of discrepancies they shall be explained and adjusted by the Engineer in Charge. The priority of the Contract documents shall be as follows:

(i) Letter of award
(ii) Special Conditions of Contract Part A & Part B
(iii) Instructions to Bidders
(iv) General Conditions of Contract
(v) Scope of Work and Technical specifications
(vi) Drawings
(vii) Schedule of prices

3.4 AUTHORITIES

3.4.1 Chief Executive Officer, USCL, Engineer in Charge, Representatives

The project shall be implemented by the Chief Executive Officer, USCL. He shall appoint Engineer(s) in Charge as Representatives who shall carry out such duties or any authority as directed by the Government.

Chief Executive Officer, USCL may also authorise consultants or institutions as Assistants. Such Assistants shall have no authority to issue any instructions to the Contractor in so far as they are necessary and to secure their acceptance of materials, Equipments and workmanship as being in accordance with the Contract. Any instructions given by them for those purposes shall be deemed to have been given by the Engineer in Charge as the Engineer's Representative.

3.5 MONTHLY REPORTS AND MEETINGS

3.5.1 Monthly Reports

Monthly progress reports shall be prepared by the Contractor and submitted to the Department in six copies. The first report shall cover the period up to the end of the first calendar month following the commencement date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the month to which it relates.

Reporting shall continue until the contractor has completed all work, which is known to be outstanding at the completion date as stated in relevant clauses of these conditions.

Each Report shall include the issues desired by the Engineer in Charge which shall be any of the following:

- Charts / detailed descriptions of progress, including each stage of design Contractor's Document, procurement, manufacturing, delivery to site of construction, direction, testing, commissioning and the trial operation;
- Photographs showing status of manufacture and of progress on the site;
- For the manufacture of each main item of equipment and materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:
    - commencement of manufacturing;
    - contractor inspections,
    - tests and
    - shipment and arrival at the site;
- Copies of quality assurance documents, test results and certificates of materials;
- Comparisons of actual and planned progress, with the details of any events or circumstances which may jeopardize the completion in accordance with the contract, and the measures being (or to be) adopted to overcome delays and the monitoring done by the contractor as per clause 3.26
- Copy of site books as per clause 3.8.3
- Any other issues deemed necessary by the engineer in charge

3.5.2 Meetings

Meetings shall be held in the office of Chief Executive Officer, USCL or at other places as mutually fixed in advance, with prior notice given by Engineer in Charge. The proposed agenda for the meetings shall be exchanged at least 1 week in advance. It is required that a decision-maker of the Contractor is present at the meetings so that binding decisions can be taken about outstanding issues. Generally, the following issues shall be discussed:

- Progress of the work, difficulties
- revision of time schedule
- Payment issues
- Disputes
- Claims
- Any other issue deemed necessary by contractor or department

3.6 RIGHT OF ACCESS TO THE SITE DURING EXECUTION

The Department shall give the contractor right of access to all parts of the site. The site for execution of the work will be made available as soon as the work is awarded. In case, it is not possible for the Department to make the entire site available on the award of the work, the Bidder shall arrange his working program accordingly. No claim, whatsoever, for not giving the site in full on award of the work or for giving the site gradually in parts will be tenable.

However, if and to the extent that the Department's failure was caused by any error or delay by the contractor, including an error in, or delay in the submission of, any of the contractor's documents, the contractor shall not be entitled to such extension of time.

3.7 THE CONTRACTOR

3.7.1 Contractor's general obligations

The contractor shall design the civil structures, execute and complete the works in accordance with the contract, and shall remedy any defects in the works. The contractor shall conduct survey & verify the levels of the proposed system(s) and lengths of the mains. The Contractor shall review the hydraulic designs of the department before execution to satisfy himself about the soundness and the safety of the designs. Finally the contractor shall be responsible for the safety & soundness of the hydraulic system & structures built under the contract so as to provide required daily design demand(s). If required, pumping head; discharge of pumps etc. shall be revised by the contractor so as to achieve the objective of the work to deliver water.

The contractor shall also confirm the feasibility of the system proposed by the department. The confirmation of the feasibility of the system proposed by the department is necessary as the final responsibility to provide designed demand(s) shall be of contractor and if required he shall provide additional equipment / material / systems to achieve the objective of the work. Unless specified otherwise, no additional payment shall be made on the account of providing the additional equipment / material / systems, change of levels, pump head & discharge, etc., and it shall be deemed that the cost of such eventuality has been accounted for in the lump sum offer.

If desired, in considerations of the survey data; the hydraulic requirement and other field limitations, the contractor so as to achieve the objectives of the work, can propose change in alignment (minor deviations to avoid structures etc., or position of pipes above or below ground etc.), etc. No additional payments shall be made on account of use of superior quality material, on this account.

In addition to the above, the contractor is also required to confirm the availability of the material required for the contract in the time schedule given herein after, so as to complete the job within the prescribed time. No time extension shall be provided on this account. If required under such circumstances, the contract after prior approval of Department shall be allowed to use superior type of material so as to complete the job within the prescribed time. No additional payments shall be made on account of use of superior quality material, on this account.

The Contractor shall provide the equipment and Contractor's Documents specified in the contract, and all Contractor's personnel, goods, consumables and other things and services, whether of a temporarily or permanent nature, required in and for this design, execution, completion and remedying of defects including O & M period .

The works shall include any work, which is necessary to satisfy the Department's requirements, or is implied by the contract, and all works, which (although not mentioned in the contract) are necessary for the completion, or safe and proper operation of the works.

The Contractor shall be responsible for the adequacy, stability and the safety of all site operations, of all methods of construction and of all the works.

The Contractor shall provide all facilities including conveyance required for verification of survey data, supervision, quality control tests, tests for material, equipment and equipment(s), and/or all other facilities otherwise referred in the conditions of contract(s) and/or otherwise necessary to complete the works with due supervision of Engineer-in-charge. The testing of material, quality

control tests, etc. may be got done through government recognized labs after approval of Engineer-in-charge.

The Contractor shall, whenever required by the Department, submit details of the arrangements and methods, which the contractor proposes to adopt for execution of the works. No significant alteration to the arrangements and methods shall be made without this having previously been notified to the Department.

3.7.2 Contractor's representative

The contractor shall appoint the Contractor's Representative and shall give them all authority necessary to act on the contractor's behalf under the contract.

Unless the Contractor's Representative is named in the Contract, the Contractor shall, prior to the Commencement Date, submit to the Department for consent the name and particulars of the person the Contractor proposes to appoint as Contractor's Representative. If consent is withheld or subsequently revoked, or if the appointed person fails to act as the Contractor's Representative, the Contractor shall similarly submit the name and particulars of another suitable person for such appointment.

The Contractor shall not, without the prior consent of the Department, revoke the appointment of the Contractor's Representative or appoint a replacement.

The Contractor's Representative shall, on behalf of the Contractor, receive instructions.

The Contractor's Representative may delegate any powers, functions and authority to any person, and may at any time revoke the delegation. Any delegation or revocation shall not to take effect until the Department has received prior notice signed by the Contractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked.

Whenever services of contractor staff are found / noticed unsatisfactory by the department, they shall be removed / terminated by the contractor immediately as per direction of Engineer in Charge

3.7.3 Setting out

The contractor shall set out the works in relation to original points, lines and levels of reference specified in the contract. The contractor shall be responsible for the correct positioning of all parts of the works, and shall rectify any error in the positions, levels, the dimensions or alignment of the works.

3.7.4 The safety procedures

The contractor shall:

(a) comply with all applicable safety regulations,

(b) take care for the safety of all person's entitled to be on the site,

(c) choose reasonable efforts to keep the site and work clear of unnecessary obstruction so as to avoid danger to these persons,

(d) provide fencing, lighting, guarding and watching of the works until completion and its taking over by the department at end of O & M period as defined in clause 1.6. of Special Conditions Part 'B'.

(e) Provide any temporary works (including road ways, foot ways, guards and fences) which may be necessary, because of the execution of works, for the use and protection of the public and of owners and occupy a server adjacent land.

3.7.5 Quality Assurance

In addition to the provisions of General conditions of contract, the contractor shall institute a quality assurance system to demonstrate compliance with requirements of the contract. The system shall be in accordance with the details stated in the contract and the Quality Assurance Program will be got approved from the competent authority. The Departments shall be entitled to audit any aspect of the system.

Details of all procedures, if adopted other than those laid down in the tender document, and compliance documents shall be submitted to the Departments for information before each design and revocation stage is commenced. When any document of a typical nature is submitted to the Department, evidence of the prior approval by the contractor himself shall be apparent on the document itself.

Compliance with the quality assurance system shall not relieve the contractor of any of his duties, obligations or responsibilities under the contract.

3.7.6 SITE DATA

Design made by the department is of preliminary in nature. However the designs made by the department, and investigations carried out by department can be seen during the execution of the contract for reference purpose.

The contractor shall be responsible for verifying and interpreting all site data. The department shall have no responsibility for accuracy, sufficiency or completeness of such data, irrespective of its use by the department while making preliminary designs.

3.7.8 Un-Foreseeable Difficulties:

(a) The contractor shall be deemed to have obtained all necessary information as to risk, contingencies and other circumstances that may influence or affect the works;

(b) by signing the contract, the contractor accepts the total responsibility for having sustained all difficulties and costs of successfully completing the works: and

(c) the contract price shall not be adjusted to take account of any unforeseen difficulties or costs.

3.7.9 Rights of Way and Facilities

The Contractor shall bear all costs and charges for special and/or temporary rights of Way, which he may require, including those for access to the site. The contractor shall also obtain, at risk and costs, any additional facilities outside the site which he may require further purposes of the works.

3.7.10 Avoidance of Interference

The contractor shall not interfere unnecessarily or improperly with:

(a) the convenience of the public, or

(b) in the access to and use and occupation of all roads and other land, irrespective of whether they are public or in the possession of the Department or others.

The contractor shall indemnify and hold the Department harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from any such unnecessary or improper interference.

3.7.11 Security of the Site

Unless otherwise stated in particular conditions:

a. the contractor shall be responsible for keeping unauthorized persons off the site, offices, campus etc. within the scope of work and
b. authorised person's shall be limited to the Contractor personnel and the Department's personnel; and to any other personnel notified to the Contractor, by (or on behalf of) the Department, and
c. Providing adequate manpower for the security of the material brought to the site for which payment has been made to the contractor.

3.7.12 Contractor's Operations On-site

The Contractor shall confine his operations to the site, and to any additional areas, which may be obtained by the Contractor and agreed by the Department as working areas. The Contractor shall take all necessary precautions to keep Contractor's equipment and Contractor personnel within the site and these additional areas, and to keep them off adjacent land.

During the execution of the works, the Contractor shall keep the site free from all unnecessary obstruction, and shall store or dispose of any Contractor's equipment or surplus materials. The Contractor shall clear away and remove from the site any wreckage, rubbish and temporary works which are no longer required.

3.7.13 Land for the Work and For the Contractor's Establishment

The land or the land rights for the sites of the permanent Work will be provided by USCL/PHED, during the progress of work. However, sufficient land and site for works shall be provided to the contractor as per the agreed execution plan submitted by the contractor and approved by the department.

For the purpose of constructing Contractor's yard, godown, site office, staff quarters, etc. the contractor may utilize the land and existing buildings / structures allocated to him by USCL/PHED after obtaining requisite permission from the Engineer in Charge. All expenses in connection with purchase or construction or maintenance or removal etc. of such items shall be borne by the Contractor.

USCL/PHED may allocate the land and buildings for use by the Contractor according to its possibilities only. If the land or buildings are not available or are insufficient for the purposes of the

Contractor's establishment, additional land or buildings will have to be procured/rented by the Contractor himself at his own cost and expenses as per his requirement.

Recovery of rent towards the use of building by contractor for office/store/residence provided by the department shall be done on fair rent assessment basis.

3.8 ORGANIZATION ON THE SITE

3.8.1 Contractor's office

The Contractor shall establish 1 Office at **Udaipur City**, and shall during office hours on all working days have a clerk or some other authorized person always present at such office, upon whom a notice may be served. Service of any notice left with such clerk or authorized person shall be deemed good, served upon the Contractor.

The contractor shall also provide reasonable office facilities for the supervisory staff of department at the site.

3.8.2 Contractor's staff

The Contractor shall employ for the execution of work only such persons as are skilled and experienced in all activities required for the completion of the Works, from reconnaissance, design, manufacturing, execution and testing to commissioning. The Engineer in Charge shall be at liberty to object to and require the Contractor to remove from the Work any person who in the opinion of the Engineer in Charge misconducts himself or is incompetent or negligent in the proper performance of his duties. Such person shall not again be employed without permission of the Engineer in Charge.

The Contractor shall employ labour in sufficient number to maintain the required rate of progress and quality to ensure workmanship of the degree specified in the Contract.

3.8.3 Site books

For the purpose of quick and efficient communication between the Engineer in Charge or his representative and the Contractor, site books shall be maintained for all sites where work is being carried out, so as to be accessible to all the concerned persons of the department from anywhere at any time. Any instructions, communication or order which the Engineer in Charge or his representative may like to issue to the Contractor will be communicated by him through such site books. The instructions thus communicated will be attended by the contractor within 3 days and remarks will be mentioned in the site book after taking remedial steps. He shall also record the hinderances occurring during execution of work. He shall also maintain the display board as per enclose formats. All the fomats are enclosed at Annexure "A".

3.8.4 CONTRACT MANAGER

He shall be person deployed by the contractor as an overall in-charge for the Contract. He shall be delegated with Power of Attorney to sign on behalf of the Contractor on all issues related to contract and payments. He should be a senior level staff member of the contractor.

3.9 DESIGN AND DRAWINGS

3.9.1 General Design Obligations

The Contractor shall be deemed to have scrutinized, prior to submission of bid, the Department's requirements (including design criteria & drawings & calculations, if any) for their correctness, accuracy, structural safety and soundness. The Contractor shall be responsible for the correctness, accuracy of all designs and for safety & soundness of all structures constructed under this contract.

The department shall not be responsible for any error, in accuracy or permission of any kind in the Department's requirements as originally included in the contract. Any data or information received by the Contract, from the department or otherwise, shall not relieve the Contractor from his responsibility for the design and execution of the works.

The details of materials indicated in the tender document are the minimum requirement, and no reduction/alteration shall be permissible unless the Engineer-in-charge is satisfied that such changes are necessary.

3.9.2 Contractor's Documents & SUBMISSION PROCEDURE FOR DETAILED DESIGN & EXECUTION DRAWINGS

The Contractor's Documents shall comprise the Technical Documents specified in the Departments requirements, Documents Requirement to satisfy all regulatory approvals and As Built Documents and Operation & Maintenance Manuals. The Contractor's Documents shall be written in the language for communications defined in contract.

If errors, omissions, ambiguity, inconsistencies, inadequacies or other defects are found in the Contractors Documents, these and the works shall be corrected at the Contractor's cost, notwithstanding any consent for approval under this clause.

GA drawings of anchor block, thrust block, valve chambers, etc. are given in the tender document. However the contractor may check to ensure soundness of the designs & successful completion of the project. The contractor is required to carry out the detail survey of the construction sites and pipe line alignments and the same shall be submitted to department for approval. The contractor is required to carry out the soil investigation and to submit the detailed structural designs and execution drawings (wherever required) all civil, mechanical and electrical engineering works. He will also submit the detailed system and working drawings as well as performance curves and data for all hydraulic, mechanical, electro-mechanical and electrical equipment.

If any changes are made in the given designs & drawings, such changes, duly done in the drawings shall be submitted for approval. No work shall be commenced on site on the basis of designs & drawings not approved by department and/or those not accepted by the contractor..

If any changes are desired by him in the given designs & drawings, such changes, duly done in the drawings with a detailed note justifying the proposed changes, shall be submitted for approval. No work shall be commenced on site on the basis of designs & drawings not approved by department and/or those not accepted by the contractor.

The drawings shall be sufficient in details and the scale has to be chosen accordingly in co-ordination with the engineer in charge.

If required, the changes in design and the execution drawings proposed by the contractor shall be submitted only after verification by an institute or agency approved by the Engineer-in-charge or any authorised representative of the Department.

3.9.3 Approval procedures

The contractor shall submit the detailed design & drawing with step wise calculations. Formulas for calculation should be clearly mentioned and nothing should be blocked or hidden. Structural design & drawing of Intake/CWR/ESR/WTP/PH etc.shall be got vetted from MNIT Jaipur/ MBM Engg College/ Kota Engineering College/ BITS Pilani/any IIT/ and such charges shall be borne by the contractor.

The following shall be the procedure for submission and approval of design, execution drawings & contractor's documents:

The Contractor shall submit three copies of design/drawings/contractor's documents to the Engineer in Charge along with the relevant IS codes / manuals and soft copy of design. All the submitted papers are to be signed by the Contractor or his authorized representatives.

The Engineer in Charge will review the submissions and if found fit for approval, will approve them and return one copy to the Contractor within 15 days duly signed in token of approval.

In case the design/drawings etc. are not found fit for approval, the Engineer in Charge will mark the comments on them and return two copies to the Contractor within 15 days and the same shall be repeated till the submissions are finally approved as per scope of work & specifications. The contractor in such cases shall submit the revised and corrected submissions within 15 days to the receipt of comments from Engineer-In-Charge.

On request of the Engineer in Charge, the Contractor shall depute the design engineer responsible for the particular submission to discuss with the Engineer in Charge or his Representative, along with software.

On receipt of approved submissions, the Contractor shall submit four (4) additional copies of the approved submissions (designs, drawings, data sheets etc.) to the USCL for reference and records.

No designs / drawings with corrections made after taking the prints will be accepted.

The approval along with alterations in drawings/designs by the Engineer in Charge shall not relieve the Contractor of his responsibility in terms of the Contract for soundness of the designs. The Contractor shall be responsible for the structural safety of all the components of the Work.

3.9.4 Discrepancies between Drawings and Specifications

In case of discrepancies between drawings and specifications or data sheets arising from the meaning, dimensions or quality of the materials and equipment for the due and proper execution of the Work, the discrepancy shall be explained by the Engineer-in-Charge. His explanation shall be the final decision and the Contractor shall execute the Work accordingly without any extra payment.

3.9.5 Contractor's Undertaking

The design, the Contractor's Documents, the execution and the completed works shall comply with the relevant standards, building, construction and environmental laws, law as applicable to the product being produced from the works, and other standards specified in the "Scope of Work & Technical Specifications" applicable to the works, or defined by the applicable laws.

All these laws, in respect of the works shall be, the laws prevailing at the time of letter of invitation. References in the contract to published standards shall be understood to be references to the edition applicable on the date of supply / execution as the case may be.

Whenever there are contradictory provisions in applicable Indian Standards, the most stringent of the provisions shall apply unless specifically mentioned otherwise.

3.10 SUPPLY OF MATERIAL

All material required for the execution of the work, testing, commissioning, trial run, operation, routine and preventive maintenance and repairs/replacement/, including chemicals for water treatment etc. if any necessitated, during the entire Operation and Maintenance period shall be arranged by the Contractor himself. Electric charges to be paid to electric company (former electricity board) during O&M period will be borne by the department.

"The contractor shall have to give a written commitment of the vendor with respect to delivery schedule that the vendor offers to commit for the present project. The vendor has to declare its production capacity and order in hand for different project to substantiate his claim for the proposed delivery schedule. The contractor shall have to countersign and agree to the delivery schedule. In case there is some difficulty from the contractor/ vendor side with the approved vendor and the contractor wishes to change the vendor, the EIC shall consider the same request subject to conditions that original delivery schedule as approved at the time of agreement with vendor shall not disturb and the contractor shall ensure timely supply of material as agreed. At the time of submission of vendor approval for all type of material, the contractor shall have to submit the proof of satisfactory performance of material in past either used by PHED/other departments/states. EIC shall approve the vendor based on the twin consideration of vendor suitability in terms of appropriate quality and production capacity along with financial capacity and commitment of timely supply of material for the project completion.

3.10.1 Samples

The contractor shall submit samples (except for samples of pumps, motors, bulk meters, valves, control panels as the inspection & testing of these items are to be done in the factory or before dispatch) for their inspection and testing is to be carried out at the factory or prior to dispatch etc. to the Department, for review in accordance with the procedure for Contractor's Documents described in relevant sub clause, as specified in the Contract and at the Contractor cost. Each sample should be labeled as to origin and intended use in the works.

The Department's Personnel or authorized representative shall at all reasonable times:

(a) have full access to all parts of the site and to all places from which natural materials are being obtained, and

(b) during production, an effective and construction (at the site and, to the extent specified in the contract, elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship, and to take the progress of manufacture of equipment and production and manufacture of materials.

The Contractor shall give the Department's personnel full opportunity to carry out these activities, including providing access the facilities, promises and safety equipment. No such activities shall relieve the Contractor from any obligation or responsibility.

The department may opt for third party (authorized by the Department) inspection also in addition to above.

Equipment of similar kind to be used in the contract shall be of same make unless specifically approved by the Engineer-in-Charge. Unless specific approval of the Engineer-in-Charge is obtained, all equipment of one kind, to be used in the project, shall be offered for inspection in one lot. If such equipment are offered in different piece meal lots, the cost of inspection of material in smaller lots will be recovered from the contractor, and the delay caused to the project on this ground, shall solely be attributed to the account of the contractor.

The contractor shall submit total 20 nos. samples of model of water meters from all size offered before procurement. Out of these meters any 5 samples shall be selected randomly and the department shall send the same duly sealed to FCRI Palghat for Type Test including Life Cycle Test (as per IS 779-1994, clause 12.4). Remaining 15 no's will be returned to bidder. The cost of these tests along with incidental charges will be borne by the Contractor. The acceptance of meters will depend on conformity to the required provisions.

If the manufacturer has the required certificate issued by FCRI Palghat after 31.03.2015 same will be accepted and no fresh test will be required to be conducted.

3.10.2 Cost for Inspection

For all Equipment(s) and material(s) required for execution of the work, the arrangement for inspection and expenses thereto shall be borne by the contractor but unless specified otherwise, the charges of inspection agency if any, shall be borne by the department for which initially payment of inspection fee to the inspection agency appointed by the department shall be made by the contractor which will be reimbursed in the subsequent bill to the contractor.

3.10.3 Testing

The Contractor shall provide all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumables, estimates, labour, materials, and suitably qualified and experienced staff in relation to supply of material and are necessary to carry out the specified test efficiently. The Contractor shall agree, with the Department, the time and place for the specified testing of any equipment, materials and other parts of the works.

The Department may, vary the location or details of specified test, or instruct the Contractor to carry out additional tests. If these varied or additional tests show that the tested equipment, materials or other workmanship is not in accordance with the contract that cost of carry out in this variation shall be borne by the contractor, notwithstanding other provisions of the contract.

The Contractor shall promptly forward to the Department duly certified reports of the tests. When the specified test has been passed, the Department shall endorse the Contractor's test certificate, or issue a certificate to him, to that effect.

3.10.4 Rejection

If as a result of an examination, inspection, measurement or testing, any equipment, materials, workmanship is found to be defective or otherwise not in accordance with the contract, the Department may reject the equipment, materials, designs or workmanship by giving notice to the Contractor, with reasons. The Contractor shall then promptly make good that effect and ensure that the rejected items compliance with the contract.

If the rejection and re-testing cause the Department to incur additional costs, the Contractor shall pay these costs to the Department.

3.10.5 Approval of Material and Equipment

The fact that the Contractor has agreed to provide the material prescribed in the Tender Documents does not release him to ask for the final approval of the equipment and material to be used for the Work. The specifications and drawings of each item to be supplied shall be individually scrutinized and the Engineer in Charge shall verify its conformity with the technical specifications and the standards.

Prior to ordering any material and equipment such as pipes, specials, measuring equipment's, mechanical and electro-mechanical equipment, electrical equipment, material for civil works and interior decoration, paints, etc. the Contractor has to supply the detailed specification, drawings, performance curves and data, operation instructions, samples etc., to the Engineer in Charge. If the Contractor has any doubts about the required specifications as prescribed in the Contract, he has to clarify them with the Engineer in Charge.

The procedure for the submission of documents, verification, re-submission if necessary and approval of these items is the same described in relevant clause, If equipment or material which the Contractor submitted first is refused in the approval process he has to submit documents of such equipment which corresponds to the specifications of the Tender Documents and which is likely to be approved.

Only after approval of the material and equipment, the Contractor can place the order or start the manufacturing or purchasing procedures.

Four weeks prior to packing and shipping the Contractor must inform the Engineer in Charge when the material/equipment is ready for inspection and testing. At this date, the Contractor shall supply the results of all manufacturer's own tests made during or after manufacturing and his own quality control certificates. The Engineer in charge will decide whether he or his representative will inspect and test the material/ equipment or whether he will approve it on the basis of the supplied documentation.

Inspection of bought out items i.e. Butterfly valve, Sluice valve, Air Valve, Kinetic Air Valve and pressure reducing Valve or any other electro-magnetic, electrical and mechanical equipment(s) shall be done by department representative(s) and / or a third party appointed by the department. The inspection charges shall be paid under provisional sum.

The Engineer in charge will provide an authorization for packing and shipment after inspection and/or approval of the material/equipment.

If the Contractor packs and ships material/ equipment without approval or authorization of the Engineer-in-Charge, it can be refused if it is not matching with the specifications of the Contract. All costs resulting from this are to be borne by the Contractor. The Contractor has then to provide the material/ equipment, which is matching with the Contract.

3.11 COMPLETION OF THE WORK

3.11.1 Time for completion

The whole of the Work, including mobilization, reconnaissance, investigations, design, manufacturing, transportation, construction, installation & testing, commissioning & trial runs, and demobilization has to be completed within a period of **24 Months** calculated from the commencement date, which is 10 days after the written order to commence the Work. The duration of the trial runs and tests is included in the completion period. The operation & maintenance period shall commence, after completion of defect liability period. Defect liability period shall commence from the next day of issue of completion certificate. The contractor shall submit a detailed time schedule for all the activities to be completed under the contract. The status of actual progress of these activities showing leg with original time schedule should be accessible to all the concerned persons of the department from anywhere at any time. If required this schedule shall be updated in each monthly meeting. However, this time schedule shall not bear any implications on the provisions of General Conditions of Contract.

Table: Milestone and Key Time Periods under Contract for sectional completion of work

S. No.	Sectional milestone	Time from stipulated date of contract start(days)	Event of Start	Activities
1.	Preparation and approval of part Service Improvement plan related to: (i) Construction of WTP, CWPS, GLSR and their electromechanical works, instrumentation, civil and campus development works. (ii) Modification of DudhTalai RWPS and installation of electromechanical and	30	Contract Signing	Preparation and approval of QAPs.

S. No.	Sectional milestone	Time from stipulated date of contract start(days)	Event of Start	Activities
	instrumentation equipments. (iii) Laying and commissioning of Distribution network in ABD Area, Udaipur. (iv) Laying of rising main.			
2.	Preparation and approval of Service Improvement Plan (SIP) for all other items.	120	Contract signing	
3.	SIP Implementation	630	Approval of SIP in part or full	Design, Construction, testing, commissioning and completion of all works as per milestones to deliver water services
4.	Rising main	180	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of rising mains
5.	Distribution Network Including house service connections in 4 DMAs of ABD area	100	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
6.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	175	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
7.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	250	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
8.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	325	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections

S. No.	Sectional milestone	Time from stipulated date of contract start(days)	Event of Start	Activities
9.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	400	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
10.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	475	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
11.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	550	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
12.	Distribution Network Including house service connections in additional 4 DMAs in ABD area.	625	Approval of SIP in part or full	Supply, laying, jointing, testing and commissioning of distribution networks including giving house service connections
13.	Construction of WTP, CWPS, clear water sump, GLSR and their electromechanical works, civil and campus development works.	540	Approval of SIP in part or full	(i) Construction of different components/ units of Water Treatment Plant, MachlaMagra. (ii) SITC of transformers and their ancillary works at MachlaMagra Campus. (iii) Construction of Clear water sump. (iv) SITC pumps, delivery valves & electrical works at MachlaMagra CWPS. (v) Construction of 5100 ML GLSR at MachlaMagra (vi) Interconnection work of Clear water sump/ CWPS to existing and proposed GLSR at MachlaMagra.

S. No.	Sectional milestone	Time from stipulated date of contract start(days)	Event of Start	Activities
				(vii) SITC of Instrumentation at MachlaMagra WTP, clear water sump, CWPS. (viii) Campus development works at MachlaMagra HWs.
14.	Modification of DudhTalai RWPS and DudhTalai JEN Office including Supply, installation and commissioning of electro-mechanical works and instrumentation at DudhTalai RWPS.	350	Approval of relevant component of SIP	(ix) SITC pumps, delivery valves & electrical works, panels at existing DudhTalai RWPS and JEN Office. (x) Civil and architectural Works and construction of cantilever structure at DudhTalai RWPS (xi) Civil and architectural Works at DudhTalai JEN Office. (xii) SITC of transformers and their ancillary works at DudhTalai RWPS.
15.	Replacement of consumer meters in areas other than ABD area.(50 % of total meters)	180	Approval of SIP in part or full	Supply & installations of consumer meters including fittings for meter in replacement of existing meters in areas, selected in pan city.
16.	Replacement of consumer meters in areas other than ABD area. (Balance 50 % meters)	180	Approval of SIP in part or full	Supply & installations of consumer meters including fittings for meter in replacement of existing meters in areas, selected in pan city.
17.	Supply, installations testing and commissioning of instruments & RTU in 50% of the pumping stations and GLSRs.	200	Approval of SIP in part or full	Supply, installations, testing and commissioning of SCADA Instruments and RTU/PLC panels in RWPS and GLSRs.

S. No.	Sectional milestone	Time from stipulated date of contract start(days)	Event of Start	Activities
18.	Supply, installations testing and commissioning of instruments & RTU in rest 50% of the pumping stations ad GLSRs	200	Approval of SIP in part or full	Supply, installations, testing and commissioning of SCADA Instruments and RTU/PLC panels in RWPS and GLSRs.
19.	Supply, installations testing and commissioning of instruments & RTU in 100% of the WTP and CWPS	400	Approval of SIP in part or full	Supply, installations, testing and commissioning of SCADA Instruments and RTU/PLC panels in WTP and CWPS.
20.	Completion of entire water supply works including preparation of as built drawing & preparation upgradation of all operation and maintenance manuals.	700	Approval of SIP in part or full	

3.11.2 Sectional and Total Physical Completion

The part of work or section thereof shall be treated as physically completed when the work or part of work or section thereof as envisaged in the Contract and essential as per site conditions, is complete and has been successfully tested sectionally or entirely under non-operation conditions to the satisfaction of the Engineer in Charge. He shall issue a Sectional Completion Certificate to the Contractor in which he shall certify the date on which the work, part of work, or section thereof has been physically completed to the satisfaction of the Engineer in Charge.

Certificate for Total Physical Completion shall be issued when all the works as envisaged in the contract and essential as per the site conditions are completed in all respect to the satisfaction of Engineer-in-Charge and the pipeline, pumping stations and all other ancillary systems are sectionally tested successfully, test gaps are closed and interconnections/connectivity made as required.

The issuance of the Sectional Completion Certificate or Total Physical Completion does not release the Contractor from his duties to maintain the work in the condition as on dates of at these sectional or total physical completion, until the end of the defect liability period.

3.11.3 Completion of work and fully commissioning

Immediately after the physical completion, the work of testing and commissioning the entire system on design conditions as per the procedure of test given in “Scope of Work & Technical Specifications” shall be taken up. Once the entire system has been successfully tested and commissioned as per the conditions of tests of commissioning referred in “Scope of Work & Technical Specifications”, the trial run period shall commence. **After successful completion of**

the trial run period of one month, and removal of all visible defects to the satisfaction of Engineer-in-Charge, the work shall be treated as "Completed".

Unless otherwise provided in the contract, after the successful completion of the testing for the entire system, the Engineer-in-charge shall issue a certificate of "Completion of Work". The date of Certificate notifying "Completion of Work" will be used for the final payment as per General Conditions of Contract. From this date of certificate for "Completion of Work", the Operation & Maintenance period shall commence.

3.11.4 Defects liability period

The defect liability period shall be of 12 months, from the next day of completion of project including trial run & commissioning as reported in the completion certificate issued by the department. The Contractor shall operate & be responsible for satisfactory performance & maintenance of the under all design and operation conditions for the duration of the defects liability period, except for damage due to unprecedented natural calamities. During the defect liability period the contract has to provide for additional training of the department staff and have to carry out the operational, maintenance and repair activities.

Constructional defect such as defects due to premature use of materials, works not executed in accordance with the Contract, hidden faults in material and equipment not discovered during inspection and testing, fault in design, manufacturing, erection and in construction shall be pointed out by the EIC and shall have to be rectified by the contractor during this period. The cost for repair material, spare arts, transport, repairs, tests and repair staff shall have to be borne by the contractor. If the Contractor fails to rectify the defect within a period of 15 days after aforesaid notice, the Engineer in Charge may forfeit the security deposit or an amount thereof required for the rectification through a third party without prejudice to any other right the Department may have against the Contractor in respect of his failure to remedy such defects.

In the case of delayed "Completion of Work" not caused by the Contractor, the defects liability period shall be extended accordingly but not more than two (2) years after the total physical completion of the entire Work, whichever is earlier.

3.11.5 Defect Liability Period If Use and operation is done before completion of work

The Engineer in Charge shall be entitled to operate any section or sections after Total Physical Completion but before Completion of work and thereupon the Engineer-in-Charge shall issue a certificate in respect thereof to the Contractor. The defect liability period and operation & maintenance period in such a case shall start from the date of start of operation. The defect liability period **shall end one (1) year after** the date of such operation. **During defect liability period no payment toward cost of material will be payable however the payment for labour engaged by contractor for O&M of the work during defect liability period shall be payable. The bidder should quote rate for O&M for first year accordingly.**

In this case, the Department at any appropriate time may ask the contractor, to perform the required test for "Completion of Work" as per clause above during the defect liability period. If the Contractor fails to perform the test for "Completion of Work", he will be liable for action as per General Conditions of Contract.

3.11.6 COST OF WATER AND ELECTRICITY FOR TESTING

For all sectional testing(s) in the contract, the contractor shall make all arrangement for such testing(s), including the water and electricity at his own. If contractor wishes to utilize water & electricity if available with department, that shall be provided on payment basis on commercial rates. The contractor shall make necessary arrangements such as installation of meter etc. for measurement of water/ electricity.

Water and Electricity for the tests of “Completion of Works” shall be arranged by the department. The raw water, power charges and cost of water treatment chemicals for this test(s) will be provided free of cost. All other charges for the lubricants, operational and maintenance staff or any other direct or indirect charges incurred by the Contractor for such test shall not be paid by the Department and if the test is performed during O & M period in operation, no deduction shall be made on this account.

3.12 AS-BUILT DRAWINGS

The submission of the as-built drawings for the equipment is the precondition for the final payment. The final drawings shall be submitted in one reproducible set and 5 copies on linen bound in an album of an approved size. The contractor shall submit all the completion drawings and approved design calculations on DVD in two copies with proper directory structure.

The contractor shall prepare, and keep up to date, a complete set of "as built" records of the execution of the works, showing the exact as built locations, sizes and details of the works as executed. The records shall be kept on the site and shall be used exclusively for the purpose of this sub clause. Two copies shall be supplied to the Department before the commencement of the tests on completion.

In addition, the contractor shall supply to the Department as built drawings of the works, showing all works as executed, and submit them to the Department for review under sub clause [Contractors Documents]. The Contractor shall obtain the consent of the Department as to their size, the references system, and other relevant details.

Prior to the issue of Completion of works certificate, the contractor shall provide to the Department the specified numbers and types of copies of the relevant as built drawings, in accordance with the Department’s requirements. The Completion of works shall not be considered until the Department has received the As Built Drawings.

3.13 OPERATION AND MAINTENANCE MANUALS

Prior to the commencement of the tests on completion, the contractor shall supply to the department provisional operation & maintenance manuals in sufficient detail as specified in ‘Scope of work & Technical Specifications’, of the tender document.

The works shall not be considered to be completed for the purposes of completion of works until the department has received final operation & maintenance manuals in such detail.

3.14 PROGRESS OF WORK

All components of works shall ensure a logical sequence of submissions, approvals, execution, construction, supply, installation, testing, commissioning, monthly reports and bills. This progress should be accessible to all the concerned persons of the department from anywhere at any time.

If any supply / construction of a material / unit is made, not in conformity to the logical sequencing of the work component, no payments will be entitled against such supplies, construction and installations.

There has to be a continuous chain of work to ensure that pipes / material supplied by the contractor are laid / installed promptly and those laid / installed are sectionally tested in the field without any delay.

If however, the progress of the work is hampered unavoidably, due to reasons beyond the control of the contractor, payment against supply shall be admissible against submission of appropriate Bank Guarantee of any scheduled bank. However such circumstances for not testing the pipes / reservoir shall be subjected to verification of the reasons, in the progress of the work, not being attributable to the contractor by an officer not below the rank of Superintending Engineer of the circle under whom the jurisdiction is vested.

The contractor will monitor status of various likely hindrances like, Environmental clearances, Forest Clearances, Gas Pipe line crossing, Land acquisition, Railway Road Canal and other crossings. Details and up dated latest status of various such likely hindrances, which may result in delayed completion of the project, should be accessible to all the concerned persons of the department from anywhere at any time.

It will be the responsibility of contractor to maintain simultaneous pro-rata progress of works

3.14.1 DOCUMENTS REQUIRED FOR PAYMENT:

The contractor shall submit the following documents in duplicate along with the invoice/bill following logical sequence as.

- ✓ Purchase invoice indicating details of equipment, material manufactured, supplied and installed or work carried out, supply value of such material or equipment or value of such work carried out and amount claimed.
- ✓ Inspection reports/ test reports/ reports certifying completion of activity with acceptable results as per USCL or any other agency representing USCL.
- ✓ Report/certificate of inspections /tests carried out by the supplier of the contractor or by the contractor himself.
- ✓ Proof of insurance of equipment, as required.
- ✓ Certificates, as prescribed, regarding payment of Sales Tax, duties etc. leviable on supplies made.
- ✓ Colour photographs of the work executed during the period for which the invoice has been raised.
- ✓ Copy of site books as per clause 3.8.3
- ✓ comparisons of actual and planned progress, with the details of any events or circumstances which may jeopardize the completion in accordance with the contract, and the measures being (or to be) adopted to overcome delays and the monitoring done by the contractor as per clause 3.26
- ✓ Any other such details/documents, as may be reasonably specified by the Engineer-in-Charge from time to time during execution of the contract.

3.16 PAYMENT TERMS

The terms of payment shall be as detailed herein after. All payments due under this contract shall be subjected to the following limitations:

3.16.1 Sequence of event in case of supply of material:

Sequence of events shall be decided in the monthly review meetings, and material requirement for subsequent 3 months shall be decided and made part of the monthly reports. Payment for supply of items in consonance with the agreed sequencing of material will only be made, so that material does not remain unutilized for more than 3 months, for which payment of supply has been made.

Payment of material and equipment shall be done for the price quoted for respective items in the "Schedule of Prices" of the tender document and as provision given herein after.

3.17 DEDUCTIONS

3.17.1 Statutory deductions

The Department is required to make statutory deductions at source from all running bills and final bill as in force through relevant statutes in force from time to time at the rates prescribed therein.

3.17.2 Other deductions

Any other deductions to recover any reduction in rates or any other Department's claims accrued as per the contract or in respect to any other liabilities arising, shall be deducted from subsequent interim payments or final payments or from the securities with the Department.

3.18 NON APPLICABLE CLAUSES OF GENERAL CONDITIONS OF CONTRACT

The clauses of General conditions of contract bearing nos. 5A, 10, 10B, 10C, 12, 12A, 24, 25, 30, 37(a), 37(b), 37(c), 37(d), 45, 45(A) & 47 and table for schedule of material to be supplied by the department If available, (referred to in clause 10) of general conditions of contract shall not be applicable.

3.19 TAXES AND DUTIES

All existing taxes, duties, levies applicable by any act of the Government of India and/or State of Rajasthan and/or of the local bodies on the company or its personnel, and any new taxes, duties, levies enforced during the contract period of work shall be borne by the Contractor. Labourcess as applicable shall also be deposited by the contractor.

All goods manufactured/procured and supplied by the contractor and the work executed under this contract, responsibility of payment of sales tax, surcharge, octroy and any other tax and levies in force, responsibility of payment of all such taxes, duties, levies shall be of the contractor.

In respect of goods and materials procured by the Contractor, for use in works under the contract, sales tax will be paid by the Contractor himself. But in respect of all such goods manufactured and supplied by the Contractor and works executed under the contract, the responsibility of payment of sales tax if is of the Engineer-in-charge as per the statutory provisions, than the sales tax for such cases shall be paid by the Engineer in Charge on behalf of the contractor and the amount so paid shall be deducted from the intermediate payments of the contractor.

3.20 PERFORMANCE GUARANTEE OF EQUIPMENT

The bidder shall guarantee that the Performance of each pump set, motor, electrical; mechanical; electro-magnetic and automation & instrumentation equipments shall comply with the requirements given in the specifications and that the equipments will operate satisfactorily at the time of commissioning and thereafter during O & M period and also at the time of handing over, at the desired level of efficiencies

3.21 DEPARTMENT'S RIGHT TO RECTIFY

The Department retains the right, at the cost of Contractor, to perform any of these materials or work obligations on default of the Contractor.

3.22 SCHEDULE OF PAYMENTS

3.22.1 For Material & Equipment

All materials and Equipment except pipe such as pipe appurtenances, pumps, motors, power cables, flow meters, valves, specials, actuators, electrical equipment, mechanical equipment, instrumentation equipment, water meters etc. which are required to be supplied and installed under this contract shall be paid as per the following breakup, subjected to the deductions as per the general and special conditions of contract:

(a) 60 % Payment

On receipt of material in good condition at site after all the required tests at the manufacturer premises, acceptance of the inspection report, other papers/warranties, required as per the conditions of contract.

(b) 30 % Payment

After installation and erection of material at site

(c) 5 % Payment

On successful pre-commissioning test performed as per the provisions given in the Chapter for "Pre-Commissioning tests" of other material/ equipment installed at site and pre-commissioning of equipments.

3.22.2 For pipeline work

(a) For Providing, laying and jointing of DI Pipes

(i) 60% On receipt of material in good condition & testing at site even after all the tests required in the manufacturer premises, acceptance of the inspection report, other papers/warranties, required as per the special conditions of contract, but the gap between supply & laying of pipes shall not be more than 4.0km for each size of pipes (for size 150mm & above) and 15.0km for each size of pipes (for size less than 150mm).

(ii) 20% of the quoted price on prorata progress, after excavation and laying and jointing of pipes in trench with specials, but the gap between laying& sectional testing shall not be more than 4.0 KM.

(iii) 10% of the quoted price on prorata progress , after completion of all pipe support; anchor; thrust block, clearing of site restoration of road & damaged properties and after sectional testing & refilling of trench of the pipeline

(iv) 10% of the quoted price on prorata progress, after successful pre-commissioning of pipe line.

There has to be a continuous chain of work to ensure that pipes provided are laid promptly and those laid are sectionally tested in the field without any delay. If however, the progress of the work is hampered unavoidably, due to reasons beyond the control of the contractor, payment against additional supply, without laying, shall be permissible after submission of appropriate Bank Guarantee of any scheduled bank. Such circumstances for not laying /testing the pipes and/or erection of equipment shall be subject to verification of the reasons not being attributable to the contractor by an officer not below the rank of Superintending Engineer under whom the jurisdiction is vested.

In consideration to the fact that the pipe lengths mentioned in the tender are the lengths based on preliminary survey and the actual length in work may vary, it is intended that the variation in lengths observed during execution shall be suitably adjusted at the end of the contract. For this purpose, the rates payable / deductible for increased / decreased lengths as compared to those given in schedule, shall be same as quoted for the respective pipe in schedule A1.

3.22.3 For material & Equipment which does not require installation

(i) For material & Equipment which does not require installation like furniture, portable meters etc:

100 % on receipt of material in good condition & receipt of invoice with all the necessary documents.

(ii) 100 % payment shall be made of tools & tackles, spare parts after inspection at store & receipt of material in good condition.

3.22.4 For Civil Works

3.22.4.2FOR PREPARATION AND APPROVAL OF SIP

(i) 50 % of the quoted cost on submission of Draft SIP.

(ii) 25 % of the quoted cost on submission of final SIP incorporating comments of department.

(iii) 25 % of the quoted cost on approval of SIP.

3.25 Makes of Equipment

The Equipment(s) used by the bidder for the project shall be one of the following makes given for each equipment, in Annexure “B” to this section of the special conditions of contract & as approved by the Technical Committee of RWSSMB, Jaipur. Makes as approved up to date of submission should not be binding and any other makes approved subsequently by the department during the execution of contract can be adopted after approval of EIC. Whenever there are more than one make available, effort would be to choose a make with mutual consent but decision of EIC in favour of superior make for better quality of material shall be binding.

In case the approved vendor has sold its firm/ factory to some other vendor and the new owner has started production under different trade name then in such case the new product with changed trade name shall not be considered part of the approved list. A fresh enlistment in such case is required.

3.25.1 Instrumentation, automation and SCADA work

Looking to substantial scope of instrumentation, automation and SCADA under this contract, the tender shall get the work executed through an experienced system integrator having minimum of following work experience:

1. Experience of supply, installation and commissioning of minimum 15 RTU's and their integration with SCADA in a single contract.
2. Experience of commissioning and integrating minimum 40 field instruments with PLC/SCADA in a single order.
3. Supply and implementation of SCADA of minimum 2000 tags for a water supply system.

Before taking up of the work of automation and SCADA, the contractor shall submit the MoU with system integrator fulfilling above conditions with specific mention of providing requisite support to maintain the automation and SCADA system for the 10 years of O & M period.

3.26 Time Schedule for Contract activities

For completion of the job in the prescribed time it is essential to maintain a timely construction schedule linking with physical progress with financial progress and logical sequencing of the contract activities. In view of the above the contractor shall submit a construction schedule based on Critical Path Method for approval of department. The work will be executed based on construction schedule submitted by the bidder. To adhere to the execution schedule approved by the department, the contractor shall also deploy the required technical expert having adequate experience of managing and monitoring construction schedule activities as directed by Engineer in Charge. The progress of these activities of the construction schedule should be accessed by all the concerned persons of the department from anywhere at any time.

The time schedule so provided and approved by competent authority shall have no bearing on clause 2 of General Conditions of Contract.

3.27 Insurance

The contractor shall have to provide a minimum insurance of man power and equipment. This insurance cover should start from the date of starting of work and should be valid up to end of execution period. The responsibility of timely payment of the premium as well as that of lodging claims as and when situation arises will be that of contractor.

3.28 ACCIDENT OR INJURY TO CONTRACTOR'S EMPLOYEES

The USCL/PHED shall not be liable for, or in respect of any damages or compensation payable by law in respect of, or in consequence of any accident or injury to any person in the employment of the contractor (other than accident or injury as may be attributable to the USCL/PHED or its employees) & the contractor shall indemnify the USCL/PHED against all such damages and compensations and against all actions, suits, claims, cost or expenses arising there from. The contractor shall insure against such liabilities and shall continue such insurance during the whole of the time that any persons are employed by him on the works.

3.29 THIRD PARTY INSURANCE

Before commencing the execution of the work, the contractor shall insure and indemnify the USCL/PHED against all damages, loss or injury and any actions, suits, claims, demands, costs and expenses arising there from which may occur to any property including that of USCL/PHED) by, or arising out of the exhibition of any work for which shall be occasion by the negligence of the contractors' employees or by defective design, materials or workmanship, or from any other cause for which the contractor may be held liable under the contract. Such insurance shall be unlimited during any period of insurance and to Rs. 1000000/- in respect to any one claim.

3.30 APPROVAL BY THE ENGINEER IN CHARGE

All insurances which the contractor requires to enter into the contract shall be effected with an insurer or insurers and in terms approved by the engineer in charge, (which approval shall not be unreasonably withheld), and the contractor shall automatically produce to the engineer in charge the policies of insurance and receipts of the payments of the premiums.

3.31 REMEDY ON CONTRACTOR'S FAILURE TO INSURE

If the contractor fails to effect on keep in force the insurances referred to or any of the insurance which he may be required to effect under the term of the contract then and in any such case the USCL/PHED may effect and keep in force any such insurance and pay such premium or premiums as may be necessary for the purpose, and from time to time deduct the amount so paid by the USCL/PHED as aforesaid, from any moneys due or which may become due to the contractor or recover the same as a debt due from the contractor.

3.32REGISTRATION OF WORKERS

As per the order passed by Hon'ble Supreme court on 18.01.10, in the civil writ petition No 318/2006, the contractor is required to get registration of workers under the act and extension of benefits to such workers under "The building and other construction workers (reputation of employment and condition of service)" Act 1996.

Annexure 'A' (Format of site book)

UDAIPUR SMART CITY LIMITED

SITE BOOK

1. **Name of Circle:**
2. **Name of Division:**
3. **Name of Work:**
4. **Location of site:**
5. **Name of Contractor:**
6. **Agreement no. & Date:**
7. **Date of Commencement of Work:**
8. **Stipulated date of Completion:**
9. **Details of In-charge of work:**

Designation	Name	Period
SE		
EE		
AE		

JE		

HINDRANCE AND DELAYS

Date of occurrence of hindrance	Details of hindrance	Date on which hindrance was overcome	Responsibility of hindrance	Signature of site in-charge with designation
(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**

Inspection notes & orders of Touring Officer

Date of Inspection	Notes and orders with signature and designation of officer making the entry	Signature of contractor or his authorised agent	Subsequent action taken	Signature of site in-charge with designation
(i)	(ii)	(iii)	(iv)	(v)

(Format of display board at site)

UDAIPUR SMART CITY LIMITED

1. कार्य का नाम.....

.....

2. कार्य स्थल का नाम.....

.....

3. स्वीकृत लागत.....

.....

4. काय प्रारम्भ होने की तिथि.....

.....

5. कार्य पूर्ण होने की तिथि.....

.....

6. ठकेदार का नाम व पता.....

.....

7. कार्य का संक्षेप विवरण.....

.....

(यदि कोई षिकायत हो तो नम्बर 0294.2421255 पर दर्ज कराएं।)

Office of the Chief Engineer (Technical) & TM RWSSMB
Public Health Engineering Department, Rajasthan
2. Civil Lines, Jaipur
Ph. 0141- 222234 E-mail- rj_tm@nic.in

No. 33/D&S /phed/2017-18/ 506-592 Date 27 /06/2017

Chief Engineer, PHED (HQ)/(R)/(SP)/(Admn.)Jaipur,

Chief Engineer, PHED (P) Jodhpur

Chief Engineer ,PHED RRWS&FMP ,GOGELAR PUMP HOUSE, NH-89 PHED, Nagaur, (Rajasthan)

Addl.Chief Engineer , PHED Region---------(All)

Subject: - List of specified makes/acceptable makes of various items to be used in Water Supply Projects/Schemes. (Up-dated Up-to 31/05/2017)

Ref.:- This Office Letter no. 33/D&S /phed/2016-17/2237-2322, dated 08.02.2017

A list of specified makes/acceptable makes of various items to be used in Water Supply Projects was circulated vide letter under reference by C E (Tech.). The above list was subject to modification, as per subsequent addition /deletion of makes by Technical Committee.

Up-dated list of specified makes/acceptable makes has been prepared and enclosed herewith, including approval of makes up-to 652nd meeting of Technical Committee dated 15.05.2017. **This up-dated list shall now be made part of tender documents of water supply projects/schemes of the department.**

23.6.2017

Chief Engineer (Tech.) & TM
RWSSMB, PHED, Jaipur
Date 27 /06/2017

No. 33/D&S /phed/2017-18/ 506-592

Copy to following:-

1- SA to Hon'ble Minister, PHED Government of Rajasthan, Jaipur.
2- PS to Addl. Chief Secretary PHED, Jaipur.
3- PS to Principal Secy. PHED, Jaipur.
4- FA & CAO, RWSSMB, Jaipur.
5- Secretary, RWSSMB, Jaipur.
6- Superintending Engineer , PHED Circle .....(All)

Superintending Engineer (D&S)
PHED, Jaipur

LIST OF SPECIFIED MAKES (Updated up to 31/05/2017)

SN	PARTICULARS OF ITEMS/ EQUIPMENTS	SPECIFIED MAKES
	BREAKER & RELAY	
1.	HIGH VOLTAGE DOUBLE BRAKE ISOLATOR WITH OR WITHOUT EARTH BRAKER	ATLAS / ABB / ELPRO / PRACTIL / SKIPPER SEIL
2.	VACCUM CIRCUIT BRAKER	ABB / BHEL / CGL / SCHNEIDER / JYPTI/ STELMEC
3.	MOULDED CASE CIRCUIT BREAKER	SCHNEIDER / L&T/ C&S / SIEMENS / HAVELLS / ABB
4.	PROTECTION RELAYS	SCHNEIDER / ABB / SIEMENS / ER
5.	HRC FUSES	L&T / SIEMENS / ER / HAVELLS
6.	CONTROL FUSES	SCHNEIDER / L&T / C&S / SIEMENS / HAVELLS
	CABLES & WIRES	
7.	HT CABLE	CCI / UNISTAR / RPG / HAVELLS / KEI/ DYNAMIC CABLES/POLYCAB/
8.	LT CABLE	CCI / INCAB / UNISTAR / RPG / NICCO / HAVELLS / KEI/ DYNAMIC CABLES/POLYCAB/VISHAL/
9.	CONTROL CABLE	CCI / UNIVERSAL / FINOFLEX / GEMSCAB / RPG / KEI / CORDS/ DYNAMIC CABLES / POLYCAB/
10.	PVC LIGHTING WIRES	FINOLEX / RPG / GEMSCAB / KEI/ POLYCAB/
	CENTRIFUGAL PUMPS	
11.	DEWATERING / POLDAR PUMP	KBL / M&P / KSB / SU/ MBH/WPIL/JASCO/ SINTECH/
12.	BACK WASH PUMPS	KIRLOSKAR / M & P / JYOTI / WPIL
13.	DOSE METERING PUMPS	ASIALMI / SWELLORF / VK/SR
14.	SLUDGE / NON-CLOG SEWAGE PUMP	KIRLOSKAR / M&P / JYOTI / MBH/WPIL/ JASCO/ SINTECH/
15.	VT PUMPS	FLOWMORE / M&P / KBL / WPIL / JYOTI / AQUA /SINTECH(Up-to 250KW)
16.	HSC PUMPS	FLOWMORE / M&P / KBL / WPIL /JYOTI / LUBI / MAXFLOW (UPTO 45KW) / **GRUNDFOS / JASCO(up-to 50KW)/ SINTECH(up-to 250KW)**
17.	SUBMERSIBLE CENTRIFUGAL PUMP	AQUA/ MBH (UP-to 50KW)/WPIL(Up-to 50KW) / JASCO(Up-to 50KW)/

LIST OF SPECIFIED MAKES (Updated up to 31/05/2017)

	FLOW METERS	
18.	ELECTROMAGNETIC FULL BORE TYPE FLOW METER	KROHNE MARSHALL / NIVO CONTROL / E&H / SIEMENS / RLT / SBEM / ABB/ ELECTRONET/ADEPT
19.	ULTRA SONIC TYPE FLOW METER	E&H / KROHNE MARSHALL / SIEMENS / NIVO CONTROL / CHETAS / RLT/**ARAD(up-to 300MM) / ELECTRONET(up-to 300MM)/ ADEPT(Insertion type and Clamp on Type)/**
20.	MECHANICAL TURBINE TYPE FLOW METER	ITRON / CAPSTAN / NIVO CONTROL / AQUAMET / RLT/ **ARAD(up-to 300MM)**
	MOTORS	
21.	H.T. MOTORS	KIRLOSKER ELCTRIC CO. LTD. (KEC.) / SIEMENS INDIA LTD. (SIEMENS) / CROMPTON GREAVES LTD. (CROMPTON) / BHARAT HEAVY ELECTRICAL LTD. (BHEL) /GENERAL ELECTRIC CO. LTD. (GEC) /NGEF (NGEF) / JYOTI/JEUMONT(Up-to 600KW)/ WEG (Up-to 5MW)/TMEIC(Up-To 5MW)
22.	L.T. MOTOR	KEC/SIEMENS / ABB/NGEF/JYOTI/ LUBI (Up-to 150KW)/ HAVELLS(Up-TO 200 KW)
23.	INDUCTION MOTOR	KEC/ NGEF/ CGL/ BHEL/ SIEMENS /
	PROCESS CONROL INSTRUMENTS	
24.	ALTERNATOR	KEC / JYOTI / AVK / CROMPTON
25.	ANNUCIATOR	MASIBUS / LETROTEK / APLAB / MINILEC / PEACON /
26.	CAPACITOR	L&T/ YASH/ KHATAU JANKAR / UNISTAR
27.	INDICATING METERS	AE / IMP / RISHAB/ E&H/ MILLBORN
28.	LEVEL INDICATOR	FORBES MARSHAL / YOKO GAWA / BELLS CONTROLS/ SBEM / E&H / RLT/ TECHTROL
29.	LEVEL SENSORS (CAPACITANCE TYPE)	LEVCON / TOSHNIWAL / PUNE TECHTROL/ SBEM / E&H / RLT
30.	LEVEL SENSORS (ULTRA SONIC TYPE)	FISHER ROSE MOUNT / HONEY WELL / VEGA INSTRUMENT/ KROHNE MARSHALL / SIEMENS / SBEM / E&H / RLT
31.	LEVEL SWITCH	FISHER ROSE MOUNT / HONEY WELL / SIEMENS / VEGA INSTRUMENT / KROHNE MARSHALL/ SBEM/ E&H / RLT/TECHTROL
32.	LEVEL TRANSMITTER	FISHER ROSE MOUNT / HONEY WELL / VEGA INSTRUMENT / KROHNE MARSHALL / SIEMENS / SBEM / E&H / RLT/**ELECTRONET**/ TECHTROL
33.	MECHANICAL FLOW	SCHLUMBERGER (ACTRIES) / CAPSTAN

LIST OF SPECIFIED MAKES (Updated up to 31/05/2017)

	INDICATOR	
34.	METERING	AE / IMP / RISHAB/ E&H
35.	MULTI FUNCTION METERS	IMP/ SIEMENS / RISHAB / AE
36.	NOISE METER	CYGNET
37.	PRESSURE GAUGE	BELLS CONTROLS/ JN MARSHAL / H GURU / MANOMETER INDIA
38.	PRESSURE INDICATOR	FISHER ROSE MOUNT/ BELLS CONTROLS / HONEYWELL / FOX BORO / E&H/ RLT
39.	PRESSURE LOGGERS	L&T / ABB / MASIBUS / LETROTEK
40.	PRESSURE TRANSMITER	FISHER ROSE MOUNT/ HONEY WELL / FOX BORO / BDO FORBES MARSHAL/ YOKO GAWA / SEIMENS/ E&H / RLT/**ELECTRONET**/
41.	RECTIFIER	CANARA ELECTRIC
	SWITCHGEAR & SWITCHGEAR PANELS	
42.	33KV SWITCHYARD CONTROL PANEL	L&T / SIEMENS / SCHNEIDER
43.	HT SWITCH GEAR PANEL	SCHNEIDER / ABB / SIEMENS / L&T/ C&S / CGL/ HT SWITCHGEARS/ SWATI SWITCHGEARS/PCE/
44.	LT SWITCH GEAR PANEL	SCHNEIDER / L&T / C&S / SIEMENS / HAVELLS/ DYNAMIC / GK MARKETING / DIVYA/ HT SWITCHGEARS/ SWATI SWITCHGEARS / ENGINEERS & ENGINEERS/ MILLBORN/ SUN AUTOMAT/ JOHNS ELECTRIC/NISH TECHNO PROJECTS/I CAM /PCE/PYROTECH/POWERTECH/
45.	CONTACTORS	ABB / L&T / C&S / SIEMENS / BCH / HAVELLS / DIVYA
46.	TOR SWITCH	L&T / KAYEES / SCHNEIDER / SIEMENS / SALZER
	TRANSFOMERS	
47.	33/6.6 KV POWER TRANSFORMER	ABB / CGL / ALSTOM / BHARAT BIJLEE / KIRLOSKAR / UTTAM (BHARAT) / VOLTAMP / VARDHMAN /ELECTRO – MECH /SKIPPER/FTS(5MVA 33/11KV)
48.	33 OR 6.6/ .433 KV AUXILIARY TRANSFORMER	ABB / CGL / ALSTOM / BHARAT- BIJLEE / KIRLOSKAR / UTTAM (BHARAT) / VOLTAMP / VARDHMAN /ELECTRO – MECH/ SKIPPER/FTS
49.	CURRENT TRANSFORMERS (CT)	ABB / BHEL / KAPPA / JYOTI / SKIPPER SEIL
50.	POTTENTIAL TRANSFORMERS (PT)	ABB/ BHEL/ KAPPA / JYOTI / SKIPPER SEIL

LIST OF SPECIFIED MAKES (Updated up to 31/05/2017)

	VALVES	
51.	AUTOMATIC FLOW CONTROL	DARLING MUESCO
52.	PRESSURE REDUCING VALVES	DARLING MUESCO
53.	BUTTER FLY VALVE	KIRLOSKER BROTHER LTD / INDIAN VALVE COMPANY/ FOURESS ENGINEERING / ADVANCE / DURGA ENGG./ MAYUR/ R&D / DALUI / JUPITER (UPTO 1600MM) / KARTAR (UPTO 250MM) / AVK / UPADHAYA / MARCK (UPTO 600MM)/ PATSONS/ VAG/CALSENS/ RG (UPTO 600 mm)/**SIGMA (up-to 800MM)/KENNEDY(up-to 1200MM)**
54.	DI Resilient (Soft) Seated BUTTERFLY VALVE	AVK /VAG/JUPITER (UPTO 700MM) / IVC / DVPL/RG (UPTO 600 mm)/ KBL (UPTO 2000 mm)/R&D(up-to 900MM)/**SIGMA (up-to 1200MM)/SHIVA(up-to300MM)/ KENNEDY(up-to 1200MM)**
55.	SLUICE VALVE	KIRLOSKAR BROTHERS LTD., PUNE / INDIAN VALVE COMPANY/ FOURESS ENGINEERING / DURGA ENGINEERING / SHIV DURGA / KEYSTONE / MAYUR / DALUI / R&D / JUPITER (UPTO1200MM) / KARTAR (UPTO 600MM) / AVK / SHIVA (UPTO 600MM) / UPADHAYA / BEW (UPTO 300MM) / PATSONS/ VAG / SACHDEVA (UPTO 1200 MM)/ CALSENS/HARI (UPTO 250MM)/RAMESH(Up-to 500MM Pn1.0 and Up-to 300MM Pn 1.6)/**SIGMA(UP-TO 800MM Pn 1.0 and Pn 1.6)/ KENNEDY(up-to 1200MM Pn1.0 and Pn1.6)/ KRANTI(up-to 200MM, CI)/**
56.	DI Resilient (Soft) Seated SLUICE VALVE	**SIGMA (UP-TO 1000MM Pn 1.0 and Pn 1.6)**/ AVK / BEW (UPTO 300MM) /VAG/ JUPIETR (UPTO 450MM)/SACHDEVA (UPTO 1000MM) / **SHIVA (UPTO 600MM Pn 1.0 and Pn1.6)** / MAYUR (UPTO 300MM) / IVC / DVPL / KARTAR (UPTO 600MM)/ KBL (UPTO 1300 mm)/R&D(up-to 900MM PN1.0 and up-to 300MM PN1.6)/ **KENNEDY(up-to 600MM Pn1.0 and Pn1.6)**
57.	DOUBLE PLATE CHECK VALVE	ADVANCE / KBL / IVC / R&D /DURGA / MAYUR / DALUI / PATSONS / VAG/ **KENNEDY(up-to 800MM)**
58.	NON RETURN VALVE	KIRLOSKAR BROTHERS LTD., PUNE / INDIAN VALVE COMPANY/ FOURESS ENGINEERING / DURGA ENGINEERING / SHIV DURGA / KEYSTONE / MAYUR / DALUI / R&D / JUPITER (UPTO1200MM) / KARTAR (UPTO 600MM) / AVK / SHIVA (UPTO 600MM) / UPADHAYA / BEW (UPTO 300MM) / PATSONS/ VAG / SACHDEVA (UPTO 1200 MM)/ CALSENS/HARI (UPTO 250MM)/ RG (UPTO 600 mm)/RAMESH(Up-to 250MM)/**SIGMA(800MM)/ KENNEDY(up-to 600MM)** / KRANTI(Up-To 150MM , CI)
59.	DI Resilient (Soft) Seated NON RETURN VALVE	AVK / VAG / IVC / DVPL/ RG (UPTO 600 mm)/ KBL (UPTO 600 mm)/ **KENNEDY(up-to 600MM / SIGMA(600MM)/ SHIVA (UPTO 600MM))/**
60.	KINETIC AIR VALVE	KIRLOSKAR BROTHER LTD. / INDIAN VALVE COMPANY / ADVANCE VALVE / INTER VALVE / FOURESS / R&D / DURGA ENGINEERING / SHIV DURGA / MAYUR / DALUI / R&D / SHIVA / UPADHAYA / BEW/ AFT/ PATSONS/ AVK / VAG /CALSENS/JUPITER/ RG (UPTO 200 mm)/**SIGMA (up-to200MM)/ KENNEDY(up-to 200MM)**

LIST OF SPECIFIED MAKES (Updated up to 31/05/2017)

61.	DI Resilient (Soft) Seated KINETIC AIR VALVE	AVK / VAG / IVC / DVPL/ RG (UPTO 200 mm)/ KBL (UPTO 150 mm)/R&D (UP-to 200MM)/ **KENNEDY(up-to 200MM)/ SIGMA (up-to200MM)/ SHIVA (UPTO 200MM)/**
62.	SLUICE GATE	JASH / BHARAT INDUSTRIAL CORP./ ORIENTAL / FLUID CONTROLS
	OTHER ITEMS	
63.	AIR CONDITIONERS (WINDOW):	VOLTAS LTD.(VOLTAS) / CARRIER AIRCON LTD (CARRIERS) / FEDDERS LLOYD./ AIRCON / BLUE STAR LTD. (BLUE STAR)
64.	AIR CONDITIONERS (MINI SPLIT):	VOLTAS LTD.(VOLTAS) / FEDDERS LLOYD./ AIRCON / BLUE STAR LTD. (BLUE STAR)
65.	BACK WASH BLOWER	KAY INTERNATIONAL / SWAM / EVERST / WEEPL/**USHA**/ACME
66.	BATTERY	EXIDE / STANDARD / FUKUWA / AMCO
67.	BATTERY CHARGER	SABNIFE POWER SYSTEM / CHHABIELECT/ UPTRON / AMCO /
68.	CHLORINATORS	INDUSTRIAL DEVICES PVT. LTD./ BANACO /IEC FABCAM LTD. / CHLOROCONTROL / TUSCON JESCO/ CONTROLMATIK ABW/SEACLORMAC/
69.	CHLORINE LEAKAGE DETECTION SYSTEM	METIJO
70.	COMPPRESSOR FOR AIR VESSEL	ANGERSOL RAND / ELGI / CP
71.	DISMANTLING JOINTS (BELLOWS TYPE)	SUR INDUSTRIES / PRECISE / BELOFLEX
72.	DISMANTLING JOINTS (TELESCOPIC TYPE)	ORIENTAL / SHIV DURGA / SUR INDUSTRIES / DWRENIND. / MANGALA / QUALITECH / SYSTEC FLEXO PRODUCT / DURGA / MAYUR / SHIVA / BEW /
73.	ELECTRICAL ACTUATOR	ROTORK / LIMITORK / AUMA INDIA / MARSH / ENTROK / **SD TORK**/
74.	EMERGENCY DG SYSTEM ENGINE	KIRLOSKAR / KIRLOSKAR-CUMMINS / GREAVES COTTON / CATER PILLAR / ASHOKA LEYLAND
75.	EXHAUST FAN	BAJAJ ELECTRICALS LTD. (BAJAJ) / GEC) / KHAITAN LTD. (KHAITAN) / JAI ENGG. WORKS.
76.	FLASH MIXURE	FABCO / PARAMOUNT / HDO / REMI
77.	INDICATING LAMPS	L&T/ BCH/ SIEMENS/ VAISHNO/ TECHNIC/ RASS/ C&S
78.	LIFTING MACHINES EOT CRANES:	EDDY CRANES ENGINEERS PVT. LTD. (EEPL) / ACME MANUFACTURES ENGINEERS (ACME) / M/S ROCKWELL HOIST CRANES PVT LTD. NEW DELHI / REWA / WH BRADDY/ JAPS
79.	LIFTING MACHINES HOIST.	EDDY CRANES / ACME / INDEX / JAPS

LIST OF SPECIFIED MAKES (Updated up to 31/05/2017)

80.	LIGHTING FIXTURES	PHILIPS / BAJAJ / MYSORE LAMPS / GE APAR / HAVELLS
81.	MOULDED WATER STORAGE TANK	SYNTEX/ POLYCON/ POLYLAKE/ LAXMI[R]
82.	OUTDOOR LIGHTENING ARRESSTOR	ALPRO / OBLUM / IGE/ SKIPPER SEIL
83.	PAINTS	ASIAN / SHALIMAR / JENSON & NICHOLSON / GOODLAC NEROLAC/ ICL / BRITISH PAINT / CLEAN COATS
84.	PLC SCADA	ABB / HONEY WELL / SCHENIDGER / L&T / SIEMENS/ E&H/GE /PHOENIX CONTACT/FORBES MARSHALL/MITSUBISHI ELECTRIC/ OMRON/
85.	PUSH BUTTON	L&T / BCH / SIEMENS / VAISHNO / TECHNIC / RASS / C&S
86.	SURGE CONTROL DEVICES (AIR VESSEL)	L&T / SHRIDHARAN / SURESEAL
87.	SURGE CONTROL DEVICES (ZVV)	SURESEAL / MANNEMANN MEER / MEGHA ENGINEERING / FLOWNIX
88.	TAPE COATING ON MS PIPE	LLOYD INSULATION/ IWL / BITU-TECH / SEAL FOR LIFE/
89.	WEIGHGING DEVICE (BRIDGE WEIGHGING DEVICE)	AVERY

SPECIAL CONDITIONS OF CONTRACT – (Water Supply -PART "B")

4.1 DEFINITIONS

4.1.1 Adverse Operating Period

The period, during which raw water from DudhTalai Pumping Station and/or electricity are/is not provided by the department.

4.1.2 Billing Period

Billing Period means each calendar month, except:

(1) First Billing Period shall begin on the Date of commencement of O&M contract as defined in clause **4.1.3** below and shall continue till the last day of the respective month of end of O&M period.

(2) The last Billing Period shall start on the first date of the month of expiry of contract and end on the date of expiry of contract as defined in clause below.

(3) During defect liability period no payment toward cost of material will be payable however the payment for labour engaged by contractor for Operation of the work during defect liability period shall be payable. The bidder should quote rate for O&M for first year accordingly.

Any computation made on the basis of a Billing Period shall be adjusted on a pro rata basis to take into account any Billing Period of less than the actual number of days in the month to which such Billing Period relates.

4.1.3 Commencement of O&M Period

O&M Period of 10 year shall start with start of 12 month defect liability period. The defect liability period shall start from next day from the date of Completion of works as per clause **3.11.3** or any other date notified after total physical completion as per clause **3.11.5,** respectively, of Special Conditions of contract Part 'A'.

However, O&M of Project facilities commissioned during execution period and any other facilities as defined in scope of work, shall be done by the contractor, for which no separate payment shall be made. The contractor shall incorporate all charges thereof in the offer.

4.1.4 Operation and Maintenance Contract Period

O&M Period shall be for 10 year which shall start with start of 12 month defect liability period.

4.1.5 Date of Issue of Taking Over Certificate

After the completion of Period, for contract as per clause **4.1.3**, provided that the contractor has fulfilled the provision of this contract.

4.1.6 Good Engineering Practice

In respect of the Contractor, its subcontractors, and all other such third party agents of the Contractor, practices, methods, techniques and standards, as changed from time to time, that are generally accepted for use internationally for water treatment facility, pump house along with its electrical &-mechanical equipment(s), all type of pipe line and pipe appurtenances, all type of meters and control equipment(s), power sub-stations, and all other facility during construction, development, operations and maintenance, taking into account conditions in India. Good engineering practice shall also mean attaining qualitative parameters of treated water as well as its disinfections including use of chemicals in consideration to the quality of raw water and norms for availability of residual; chlorine at the end point. In this regard water supply manual and directions of EIC with respect to any contingency shall also be applicable.

4.1.7 Non-conformance Event

Any occasion on which the Contractor does not supply the notified per day flow (As notified by the department) to the Consumers in ABD area.

Any occasion on which the Contractor does not supply the notified per day flow to theDudhTalai WTP, Patel Circle WTP, MachlaMagra WTP.

Any occasion on which the Contractor does not produce the notified per day clear water at MachlaMagra WTP.

4.1.8 Operation and Maintenance Completion Certificate

As defined in **Clause 4.2** of this Project.

4.1.9 Operations and Maintenance Services

All Services which are the responsibility of the Contractor and are required to fulfill the obligation as detailed in “scope of work” given in Vol. II of bid document and/or in the approved operation and maintenance manual and as defined in any other clauses of this contract.

4.2 Extension & Expiry of Contract

4.2.1 Extension of Operation and Maintenance Period

4.2.1.1 The Operations & Maintenance Period can be extended up to another period of 6 years based on such terms as acceptable to both Parties (“The Contractor” and the “Department”)

4.2.1.2 In such an event, either Party (“The Contractor” or the “Department”) shall notify its intention to extend the Operations & Maintenance Period at least six months before its expiry and commence discussions with the other Party to arrive at a mutually agreed basis of terms and conditions for the extended period.

4.2.2 Expiry of the Operation and Maintenance Period & Taking Over By the Department

4.2.2.1 Six months prior to the expiry period, the Department will notify the contractor, the maintenance required for the facilities including all structures and road, plants, materials and equipment(s) therein, so that the facilities may be taken over in an acceptable physical conditions (physical conditions in reference to the initial physical condition at the start of O&M period, after accounting reasonable wear and tear during operation) and in operation conditions.

4.2.2.2 Notwithstanding to the notification done by department, the contractor shall repair, maintain and operate the facilities as per the terms and conditions of this contract, till 12.00 Noon upto the date of expiry of contract period.

4.2.2.3 The contractor, shall be liable for all defects, faults, break downs etc. occurred or noticed prior to the 12.00 Noon, upto the date of expiry of contract, even if the facilities are taken

over by the department subsequently, due to expiry of contract period,. However, the Department has to notify all such defects/liabilities of contractor within 30 days of taking over of facilities.

4.2.2.4 Till the date of expiry of contract period, the contractor shall do all routine and periodic maintenance as prescribed in the O&M manual, in force, at the time of expiry of contract.

4.2.2.5 On expiry of contract, the contractor shall hand over all spares, tools and for which he has been paid.

4.2.2.6 After, expiry of the contract, the contractor shall provide 12 copies of the updated O&M manual. The components of communication system used during O&M period in operating condition, the T&P required for maintenance of facilities. The log books and all the other records prepared during the O&M period, shall be handed over to the Department, in acceptable electronic formats and in hard copies, within 15 days of expiry of contract. Copy of the log books related to performance of units shall be provided every month.

4.2.2.7 If the contractor does not comply with any of the provisions above, or any other requirement in pursuance of Good Industrial Practices, the Engineer –In-charge shall estimate the cost of liabilities due to violation of any of the provisions of this contract. Such estimates made by Engineer-In-Charge shall be final and binding for the contractor. However in a reasonable endeavor, such estimates shall be communicated to the contractor, within 30 days of expiry of the contract. The contractor shall be given an opportunity to rectify the damages through his staff/agents, or for supply of required material provided such rectification of defects on maintenance do not require any shut down of the system, within 60 days of such notification of estimates by department.

4.2.2.8 Within 120 days of expiry of the contract period as per clause 1.6, the Department shall prepare the final estimates for recovery from the contractor and shall prepare the final bill for the work.

4.2.2.9 If the recoveries to be done by Department are more than the final bill to be paid, the contractor shall deposit the required amount to be recovered from contractor or this amount shall be recovered from the securities/guarantees etc. with the department as deemed suitable.

4.2.2.10 After the date of expiry of contract and recoveries of all dues payable by the contractor, the Engineer-In-Charge shall issue a "Certificate of Taking over."

4.3 OPERATIONS

4.3.1.1 Water Supply shall include but not limited to, the operation, maintenance and repairs of all existing and new assets created for the water supply system of ABD area to be kept in operation to deliver the services, from DudhTalai RWPS to the supply of metered drinking water at consumer end. This involves operation & maintenance of DudhTalai RWPS, MachlaMagra WTP, MachlaMagra CWPS, existing and proposed GLSRs in MachlaMagra Campus, clear water sump MachlaMagra, exisiting and proposed rising main for MachlaMagra WTP, proposed rising mains for different WTPs, existing rising main to DudhTalai WTP till its replacement in different project, distribution network within the ABD area, House service connections.

4.3.1.2 Continuous Pressurized Water Supply means a continuous supply of water for 24 hours a day, at a minimum pressure 17 meters of water at ferrule point. Continuous supply and pressure to be measured at Critical Points in the zone from mid night to mid night.

4.3.1.3 Critical Points in the zone means the points on the distribution network at which the flow or pressure measuring devices would be installed which shall be mutually agreed by the Employer and the Contractor during the works contract.

4.3.1.4 Nonrevenue Water (NRW)

NRW = System Input Volume (SI) – Billed AuthorizedConsumption (BC)

Where
a. SI shall be the sum of quantity of bulk water drawn in to ABD area distribution system as measured by flow meters installed at RWPS, WTP, CWPS, DMA inlet, between the consumer billing cycle period.
b. BC is the sum of water billed to the consumers in the ABD service area for billing cycle period.

4.3.2 Performance Targets

I Water Supply:

The Operator must meet following Performance Targets on monthly basis:

i. Continuous 24 hours a day, Pressured Water Supply must be provided to the properties with authorized connection(s) in ABD service area.
ii. Non-Revenue Water
iii. Adhering to HSC connection and disconnection request in time.
iv. Functionality of consumer meters supplied under the contract.
v. Functionality of measuring instrument supplied and installed under the contract.

4.3.3 Methodology for Measurement of Performance

The Contractor shall develop a robust methodology and framework for measurement and monitoring of Performance Standards stipulated under this clause and proposed as part of the Service Improvement Plan (SIP). The Employer shall review the same and upon agreement between the Parties, the agreed methodology shall form the basis for monitoring the performance of the Contractor and apply the Performance Payment.

4.3.4 . Parameter, Minimum Service Level, Measurement and Monitoring System of Performance Indicators/Standards

Water supply

S.No.	Description	Details
1	**Parameter**	**Continuous Pressured Water Supply must be provided to the properties with authorized connection(s)**
	Minimum Service Level	90 % of the pressure readings maintained at a minimum 17 meters of water at consumer meter point. To be achieved at the end of District Metering Area (DMA) commissioning date and maintained throughout the contract period.
	Measured by	Two CMP will be established in each DMA as per approved Service Improvement Plan (SIP). Readings at the CMPs will be

		taken on hourly basis during supply hours through pressure sensors connected with SCADA. Compliance on continuity of service = 100* (Total Number of readings of pressure equal to or more than 17m/ Total number of readings of pressure in the service area). For illustration purpose, if an area of 10,000 connection in 20 DMAs is in service. Total CMPs in 20 DMAs are 40. Hourly readings are 24 in a day at each CMP and the month is of 30 days. Total readings in a month will be 40X24X30 = 28,800. If 25920 readings (which is 90% of 28800) is equal to or more than 17 m, Contractor will be eligible for getting performance fees under this criteria. If 17 m pressure readings are less than 25,920, Contractor will not be eligible for getting performance fees under this criteria.
	Monitored by	An electronic registry maintained by the Contractor; the registry shall include detailed database and summary tables pressure logs at each of the CMP The pressure log database shall include: • Time and date • CMP identification number • Pressure in meters
	Allowable Exclusions	i. Planned maintenance periods not exceeding 8 hours each ii. Interruption due to mains bursts not exceeding 12 hours iii. Shortage of bulk water supplied by bulk supply provider iv. Third party causes like power failure and fire fighting
2	**Parameter**	**Non-Revenue Water (applicable after final takeover date)**
	Maximum level	Less than or equal to 15 %.
	Measured by	Water supplied – Water billed, where water supplied shall be the quantity of bulk water drawn from DMA inlet point (and comparison with total clear water produced at MachlaMagra WTP) and the water billed is sum of water measured at consumer meters of all the Consumers as per billing records for the month. Consumption of non-working meters during the month will be calculated on the basis of average of preceding three months or last year month consumption whoever is higher will be added to the water consumed.
	Monitored by	Electronic registry for bulk flow meter and the corresponding electronic registry of consumer meter readings as per the billing records for the month under review as maintained by the billing agency.
2 A	**Parameter**	**Non-Revenue Water for DMA (from initial take Over Date to final take over date)**
	Maximum Level	Less than or equal to 12%
	Measured by	Water supplied – Water billed, where water supplied shall be the quantity of Bulk water supplied in DMA measured at DMA entry point and the water billed is sum of water measured at consumer

		meters of all the Consumers in DMA as per billing records for the Month. Consumption of non-working meters during the month will be calculated on the basis of average of preceding three months and will be added to the water consumed.
	Monitored by	Electronic registry from bulk flow meter at DMA and consumer meter readings as per the billing records for the month under review
3	**Parameter**	**Adhering to HSC connection and disconnection request in time**
	Minimum Service level	100 %
	Measured by	No. of connections/disconnections given in 3 days of clearance received from line agency X 100 / Total no. of connections cleared
	Monitored by	The electronic register of dated requests for connections received, cleared by authority and actually connected as per the signed report of consumer.
4	**Parameter**	**Functionality of Consumer Meters**
	Minimum Service level	95% of meters are to be found functional in any billing cycle.
	Measured by	Through the meter reading by PHED personnel or by third party
	Monitored by	For the period under review through: The Electronic register of authorized connections, the MIS prepared by billing agency (This parting in which the number of non-functional/defective meters are reported.
	Allowable Exclusions	Nil
5	**Parameter**	**Functionality of Electronic measuring instruments supplied and installed under the contract**
		95 % of instruments shall be operational at any point of time.
	Measured by	Percentage of total number of working measuring instruments supplied and installed under the contract.
	Monitored by	Electronic registry to be maintained by the central SCADA at specified location by USCL.

4.4 PAYMENTS

4.4.1 Basic Service Charge (BS)

The Basic Service Charges shall comprise all expenses for operation and maintaining the Facilities, as provided in the scope of work for O&M in Volume – II of "Scope of Work and Technical Specifications" of bid document. In addition to the cost of material/equipment spares, replacement of equipment, all other expenses such as expenses for administration and management, permanent & temporary staff, running office, maintenance of all structures, updating of operation and maintenance manual, etc. and all other incidental and indirect expenses for the works detailed in "Scope of Work for O&M" in Vol-II or for works otherwise required as per good engineering practices for Operation and maintenance of the entire system, (except for the cost of electricity) are included in this Basic Service Charges. The Basic Service Charge shall be a lump sum charge to be quoted by Contractor at the time of bidding in Schedule of prices in Volume IV of bid document.

4.4.2 Payment on Basic Services

Payment for the Basic Services would comprise two components, namely Fixed payment and Performance payment, as follows:

(a) Fixed Payment equal to 70% of the eligible Total Payment for Operation Services with service delivery in water supply;

(b) Performance Payment equal to 30% of the eligible Total Payment for Basic Services with service delivery in water supply system **as per Schedule of Performance Target and Measurement**

USCL shall pay the fixed Payment to the Contractor within 30 days of raising the monthly bills. The monthly payment bills will be reviewed and certified by the EIC representative/ Auditing Body/ Technical Auditor within 15 days of submission by the Contractor. Eligible performance Payment and other charges, if any, will be paid on Certification, within 15 days of recommendation by the Employer's representative/ Technical Auditor along with a certificate regarding fulfillment of the performance conditions and the Technical Auditor's report.

4.4.3 Fixed Payment

The Fixed Payment shall be paid to the Contractor on monthly basis subject to fulfillment of the following conditions:

(i) Maintaining the minimum personnel as specified in contract for the billing month.
(ii) Compliance with the obligations under the Contract.
(iii) Providing daily water supply to the citizens in the service area (except the extraordinary situation where water is not supplied by PHED).

The essence of the contract is achieving superior performance in service delivery to the end user. Towards achieving this, deductions as proposed below shall be made from the fixed Payment in case of below satisfactory or inferior performance in achieving the performance indicators.

Contractor is eligible to get full 70% of the agreed Basic Services Payment as fixed Payment only if he achieves performance indicators with mandatory achievement of performance criteria regarding **Continuous Pressured Water Supply** and **Non-Revenue Water** sufficient enough to get 50% of the maximum Performance Payment i.e. out of 5 performance parameters. In case the Contractor gets less than 50% of the maximum Performance Payment of 30%, deductions at the following rates shall be made from the fixed Payment for below satisfactory or inferior performance.

Performance Payment payable to the Contractor during the payment period (As percentage of total agreed Payment for Operation Services for the corresponding payment period)	Fixed Payment payable to the Contractor (As percentage of total agreed Payment for Operation Services for the corresponding payment period)
15% or More	70%
Less than 15% but more than or equal to 10%	60%
Less than 10% but more than or equal to 5%	50%
Below 5%	0%

4.4.4 Reduction OF RATES (RR)

4.4.4.1. Measurement of Flows For Reduction In Rates

4.4.4.1.1. For this clause, the day shall mean the duration between 12.00 noon of preceding day and 12.00 noon of the day in question

4.4.4.1.2. The flow rate for the day in question will be calculated by dividing the total flow during the day by the duration of operation of system within that day.

4.4.4.1.3. For the purposes of payment of Reduction in Rates, Metering is of utmost importance in this contract. For flow measurements, meters shall be installed. Similarly one water meter shall be installed at inlet of each GLSR. One meter, each on the starting of delivery mains, of Pumping Station, shall be installed. Meters shall also be installed at all District Metering Areas.

4.4.4.1.4. Reading of meters at CWRs/PS/GLSRs, shall be recorded everyday & reading of meters of District Metering Areas shall be taken every month through SCADA system and manually in case of SCADA system being non-functional and will be signed by representatives of Department and Contractor.

4.4.4.1.5. If doubt is raised by any of the party, in reference to the correctness of the meters, anstrap on type portable ultrasonic flow meter shall be installed in series and the reading of the meter under question shall be compared with that of ultrasonic meter (the ultra-sonic meter shall be provided by the contractor). If the difference is within $\pm$ 4 %, no change of meter will be done. If it is beyond this limit, the meter must be replaced/repaired within 96 hours by the Contractor. If no meter is functional at terminal points, the flow as per historical trends shall be calculated by Engineer-in-Charge using PS /Off-takes /GLSRs /Distribution Zones meter readings or logbook data of pumps, his assessment of flow shall be treated final. In case the six monthly calibration is delayed beyond 15 days grace period, a reduction of 100 Rs/Day/meter shall be recovered from the monthly O&M bills.

4.4.4.1.6. The water consumption data shall be properly recorded and should be accessible to departmental officials from anywhere at any time.

4.4.4.1.7. At all times, the contractor will ensure that sufficient spares for meters are available, so as to keep meters functional for the maximum time at each location.

4.4.4.1.8. If any of the main meter(s) installed at PS/GLSR/CWR/DMA is not functioning for a continuous period of more than 96 hours, it shall warrant a reduction in rates of Rs. 5000 per day per meter, from 5th day onwards. Meters at locations at other places, if not repaired within 96 hours or a stand-by meter is not installed in its place, shall warrant a reduction in rate of Rs. 2000 per day per meter.

4.4.4.1.9. If any of the pressure sensor, level sensor is not functioning for a continuous period of more than 96 hours, it shall warrant a reduction in rates of Rs. 100 per day per instrument, from 5th day onwards.

4.4.4.1.10. The daily flow rates recorded as above shall be totaled for each month and the same shall be used for calculation of reduction in rates of described clause 4.3.2.3 below.

4.4.4.1.11. In event of Break down or shutdown due to other reasons or due to other circumstance, if the flow has been maintained for part of the day, than the average flow rate for such ": part day" flows, shall be calculated as referred above.

4.4.4.1.12. The domestic meters reported out of order within the contract period shall be replaced from the site within 3 days from receipt of written intimation from PHED, Failure to comply this will be liable for penalty of Rs. 50/- per day per meter. Subject to maximum of Rs. 500/-Transportation & other charges shall be borne by the contractor. The meter so repaired will have accuracy as per BIS/ISO/EEC/MID which shall be witnessed by PHED representative. If the meter cannot be repaired than is to be replaced as per specification of Vo. II of Tender Document.

4.4.4.2. Reduction in rates for supply of less Quantity of Water & for high percentage of leakages

4.4.4.2.1. The total losses in the pumping mains i.e. from Source to Machla Magra WTP & from Pumping stations to GLSRs, estimated on the basis of flow meters installed at pumping

stations, GLSRs, CWRs, shall be limited to 2% of the total flow pumped from pumping stations. For losses more than 2% of the flow, the reduction in rates @ Rs. 5 per KL of water in excess of permissible 2%, shall be levied. The rate of reduction i.e. Rs. 5 per KL shall be increased by 12.5% every year, during the O & M period.

4.4.4.2.2. The total quantity of flow to be released from the Ground Level Service Reservoirs shall be equal to the summation of the quantum of flow desired at DMA as notified by the department.

4.4.4.2.3. The total losses, estimated on the basis of consumption data of all the consumers by consumer meters installed & collected by IMIS vendor, shall be limited to 17% of the total flow released from the Ground Level Service Reservoirs for DMAs where the contractor has laid part distribution system. For losses more than 15% of the flow, the reduction in rates @ Rs. 5 per KL of water in excess of permissible 15%, shall be levied. The rate of reduction i.e. Rs. 5 per KL shall be increased by 12.5% every year, during the O & M period.

The total losses, estimated on the basis of consumption data of all the consumers by consumer meters installed & collected by IMIS vendor, shall be limited to 10 % of the total flow released from the Ground Level Service Reservoirs for DMAs where the contractor has laid full new distribution system. For losses more than 10% of the flow, the reduction in rates @ Rs. 5 per KL of water in excess of permissible 10%, shall be levied. The rate of reduction i.e. Rs. 5 per KL shall be increased by 12.5% every year, during the O & M period.

4.4.4.2.4. While limiting the total losses in the system (raw water as well as clear water) to 20 %/ 17 % (for old/new distribution system), the contractor is also responsible for controlling the flow in the system in such a manner that all the District Metering Areas are provided with at least 90% of the notified or designed quantity of per day demand. (The notified demand shall always be less than the designed demand unless mutually agreed by both parties). Failing to supply 90% of desired quantity shall invite a token compensation of Rs. 500/- per DMA per day if this happens for a period of more than one day and if complaints are received from respective DMA of getting in-sufficient water.

4.4.4.3. Reduction in rates for not maintaining power factor

The contractor shall do all necessary arrangements to maintain the power factor of 0.98 for system installed under this contract at all installations/pump houses which are being proposed new under this contract. The contractor should integrate it with entire system. For pump houses, WTP which are being constructed new under this contract or in existing pump houses where all pump sets and electrical installations are being replaced under the contract the responsibility of maintaining power factor 0.98 is with the contractor.

If lower power factor against 0.98 leads to any loss of admissible rebate by the power supply companies, the contractor shall be liable for deduction equivalent to the sum of such amount etc. imposed by the power supply company for not maintaining the required power factor. If the power factor is above 0.95 but less than 0.98, the loss in incentive to the department given by the power supply company will be borne by the contractor. However, if the power factor is kept above 0.98 by the contractor, the contractor shall receive 50% of the extra incentive received by the department as bonus for keeping power factor above 0.98.

4.4.4.4. Reduction in rates For Inefficient Operation of Pumping Machinery

4.4.4.4.1. Throughout the O&M period, the contractor shall ensure operation of the pumping machinery within 5% of the efficiency of pump, as per its approved Performance Curve, at the time of supply.
Example: If pump efficiency as per approved performance curve is 70%, allowable tolerance in operating efficiency shall be **70 X 5% = 3.5%.**

4.4.4.4.2. The approve efficiency with in the approved operating range, at the time of supplyof the pumps installed under the contract shall be maintained throughout the contract period with a permissible reduction of **0.40 %** efficiency per year after 1 year of operation of pump throughout the entire O&M period.

4.4.4.4.3. Every month, the actual energy consumption of the pumps shall be compared with the agreed guaranteed calculated energy consumption based on approved efficiency with in the approved operating range and quantity of water pumped & average operating pressure during the month for different lake levels as measured by level sensor installed at the lake. The guaranteed calculated power consumption as calculated by the department is at **Annexure-1** of Volume II of Tender Document. The record sheet for daily energy consumption is at **Annexure-2** of Volume II of Tender Document.

4.4.4.4.4. In case the actual energy consumption of the pumps, during a month, exceeds the guaranteed calculated energy consumption calculated with allowable tolerance in efficiency, the cost of excess energy charges shall be deducted from the monthly O&M charges to be paid to the contractor. If the actual energy consumption of the pumps, during a month, is less than the guaranteed calculated energy consumption calculated with allowable tolerance in efficiency, the contractor shall receive 50 % of the total savings in the monthly electricity bills as bonus.

4.4.5 Performance Payment and damages

A maximum of 30% of the total agreed Payment for Basic Services will be based on achieving performance as shown in **Schedule of Performance Target and Measurement** during Basic Services under the contract. Contractor is eligible to get performance payment i.e., 30% if he meets the threshold limits of all the performance indicators. The breakdown of performance payment related to performance indicators are listed.

4.4.6 Performance Payment for Water Supply System

Breakup for various criteria in water supply system is as given below:

S. No.	Parameters and reference	% of eligible monthly Basic Service Payment
1.	Continuous pressured water supply	5 %
2.	Ensure the level of NRW in specified range	5 %
3.	Adhering to HSC connection and disconnection request in time.	5%
4.	Functionality of consumer meters supplied and installed under the contract	5%
5.	Functionality instruments supplied and installed through the contract	5%
6.	Operational Efficiency of pumps supplied under the contract to sustain as per specification.	5%
	Total	30%

4.4.7 Taxes and Duties

4.4.7.1. The Contractor shall be responsible for paying all taxes / duties including service taxes, labour tax, cess or any other levies imposed by the Government and assessed as due

and payable by the Contractor associated with the carrying out of the services. Notwithstanding the provisions of any Clause of this Conditions of Contract for Operation and Maintenance, the Department shall be entitled to withhold or deduct from payment to the Contractor any amount demanded by the competent authority.

4.4.7.2. All statutory deductions shall be made from all the payments done to the contractor.

4.4.8 Security Deposit

4.4.8.1. The provisions of Clause 1 of General Conditions of Contract shall apply for the deductions to be made in reference to the Security Deposit.

4.4.9 Refund of Security Deposit

4.4.9.1. The Security Deposit with the Department shall be released within 30 days, after successful completion of defect liability period as per relevant clause of special condition of contract (Part-"A") for execution part & within 30 days after issue of certificate for successful completion and taking over of O&M work in pursuance of relevant clause of Special conditions of contract (Part-"B") for O&M in proportionate to the ordered cost for execution (Part-A) and O&M (Part-B) respectively provided final bill is paid for respective part of the contract.

4.4.9.2. **Departments estimated cost for 10 year O&M of the project is 17% of the total cost of tender. Therefore, an amount equal to 10% of department's estimated cost of 10 year O&M or ordered cost of 10 year O&M, whichever is higher, shall be retained on account of security deposit for O&M work (Part-B) from security deposit for execution work (Part-A) while refunding such security deposit**.

4.4.10 Insurance

The contractor shall have to provide a minimum insurance of man power and equipment. This insurance cover should start from the date of starting of work and should be valid up to end of execution period. The contractor shall have to provide a minimum insurance of man power and equipment during O & M period of 9 years also. The responsibility of timely payment of the premium as well as that of lodging claims as and when situation arises will be that of contractor.

4.4.11 ACCIDENT OR INJURY TO CONTRACTOR'S EMPLOYEES

The USCL/PHED shall not be liable for, or in respect of any damages or compensation payable by law in respect of, or in consequence of any accident or injury to any person in the employment of the contractor (other than accident or injury as may be attributable to the USCL/PHED or its employees) & the contractor shall indemnify the USCL/PHED against all such damages and compensations and against all actions, suits, claims, cost or expenses arising there from. The contractor shall insure against such liabilities and shall continue such insurance during the whole of the time that any persons are employed by him on the works.

4.4.11.1. APPROVAL BY THE ENGINEER IN CHARGE

All insurances which the contractor requires to enter into the contract shall be effected with an insurer or insurers and in terms approved by the engineer in charge, (which approval shall not be unreasonably withheld), and the contractor shall automatically produce to the engineer in charge the policies of insurance and receipts of the payments of the premiums.

4.4.11.2. REMEDY ON CONTRACTOR'S FAILURE TO INSURE

Contractor should submit the proof of insurance prior to submission of R.A. bill. Failure to this no any type of payment shall be made to contractor for which the contractor himself shall be fully responsible.

4.4.12 Variability of Output

4.4.12.1. Variation in Supplied Water Quantity required by Department

4.4.12.1.1. The Department may alter its demand requests made pursuant to this Clause for any reason whatsoever by giving the Contractor a written notice.

4.4.12.1.2. Regardless of the quantity of Supplied Water demanded by the Department, or even if the contractor is not supplying any water due to non-availability of the water the Department shall be liable to pay to the Contractor the Basic Service Charge as defined in Clauses 4.3.1.

4.4.12.2. Due to contractor's own inability

4.4.12.2.1. If the contractor fails to provide 98% of the required water as notified by the department which shall be limited to the maximum design flow as asked in the scope of work & specifications, the contractor shall be liable to compensation, as per clause 4.4.2.

4.4.13 Adverse Operating Conditions

4.4.13.1. Non-availability of Raw Water

4.4.13.1.1. Lower lake levels then permissible drawl point and adequate amount of raw water is not available to produce desired flow,the Parties shall consult in good faith to arrive at mutually acceptable Alternative Output Standards, which shall be complied with by the Contractor till such time adequate water level is restored by the Department.

4.4.13.1.2. Notwithstanding the above, pursuant to relevant clauses of this Conditions of Contract, inability of the Department to supply Water shall not construe default by Department.

4.4.13.1.3. During such period when the Department supplies no water, the Department shall be liable to pay to the Contractor the Basic Service Charge pursuant to relevant clauses of this Conditions of Contract.

4.4.13.2. Non availability of power

4.4.13.2.1. If O&M of power transmission line is responsibility of contractor and therefore non running of the system due to power is also on contractor's part. Contractor will ensure repair of breakdown of dedicated feeder within 12 hours of occurrence failing which prorate reduction in production of water will be done and no service charges will be paid.

4.4.13.2.2. If, due to reasons attributable to the Department, adequate power to operate the Facility is not provided, the Parties shall consult in good faith to arrive at mutually acceptable Alternative Output Standards, which shall be complied with by the Contractor till such time adequate power supply to the Facility is restored by the Department.

4.4.13.2.3. All power outages equal to or more than 1 hours (total) in a segment of 24 hours (12:00 Noon to 12:00 Noon next day) shall be used for determining pro-rata reduction on Quantum of Water to be supplied as per Departments instructions.

4.4.14 Personnel

4.4.14.1. The Contractor shall appoint the minimum staff defined in scope of work of O&M in Volume - II, before the date of issue of Certificate for Completion of work under **clause 11.3** of special condition of contract part "A". The appointed staff must have the minimum qualification and experience as defined in the Chapter of "Specifications for Operation and Maintenance" of Volume-II. The names along with the qualifications and experience of the minimum staff to be provided as per the conditions of contract shall be got approved from the Department. Such approval shall not be unreasonably withheld or delayed by the Department. If during the O&M period any personals earlier approved by Department are required to be changed, the bidder shall provide CV's of personals of similar or more experience than that of the person to be replaced for

approval of Department. Only after such approvals, the bidder shall appoint the person on job.

4.4.14.2. The Contractor's Representative shall be authorised and empowered to act for and on behalf of the Contractor on all matters relating to the rights and obligations of the Contractor during the O&M Period. In all such matters, the Contractor shall be bound by the written communications, directions, requests and decisions given or made by the Contractor's Representative.

4.4.14.3. The Contractor's Representative will direct and manage the Contractor's resources and have full responsibility for the operation, maintenance and administration of the Facility.

4.4.14.4. The Contractor shall identify, interview and hire sufficient number of qualified and trained (and if required, licensed) personnel to perform its obligations during the O&M Period.

4.4.14.5. All Contractor's personnel employed at any time during the O&M period will be provided by the Contractor. The Department is not liable for personnel in any way and cannot be held responsible in the event of litigation of any sort between the Contractor and members of plant personnel or their representatives or non-performance of obligations due to any strike or other industrial action by the Contractor's workmen (including those of its subcontractors, suppliers etc).

4.4.14.6. The Contractor undertakes to comply with applicable legislation and the code of labour law on matters of health, hygiene and safety, and shall assume responsibility for works required in the event of any change in applicable regulations and shall also require its subcontractors to comply with this clause.

4.4.14.7. If the Contractor fails to provide the minimum personnel responsible for O&M of the Facility as defined in scope of work, given in volume-II, the Basic Service Charge payable for each year may be reduced proportionately to the schedule of deployment of personnel proposed by the contractor or as per the actual expenditure incurred by the Department to fulfill the duties and liabilities of the Contractor under this contract, whichever is more, at Department's discretion.

4.4.15 Maintenance, Repairs and Replacements and Additions to the Facility

4.4.15.1. Maintenance, Repairs and Replacements

4.4.15.1.1. The Contractor at its own cost and expense shall maintain and repair the Facility in good working condition, in a neat & orderly way including the cleanup of litter and debris on a daily basis or more frequently, shall maintain a spare parts inventory necessary to performance maintenance required as per the Operation and Maintenance Manual and/or scope of work, and shall maintain the aesthetic quality of the Facility as originally constructed and in accordance with the Technical Specifications, with due allowance for reasonable wear and tear and depreciation. The Contractor shall provide or make provisions for all labour, materials, and equipment which are necessary for the normal operation and maintenance of the Facility and shall conduct the required predictive and preventive maintenance of the Facility consistent with the Operation and Maintenance Manual and/or scope of work. The details of scheduled dates of preventive maintenance of all material and equipment and details of preventive maintenance done should be recorded and this should be accessible to all the concerned persons of the department from anywhere at any time. The Contractor shall maintain maintenance logs in accordance with the preventive maintenance plan set forth in the Operations and Maintenance Manual and as defined in scope of work and shall produce monthly copies of the same to department.

4.4.15.2. Additions/Modifications to the Facility

4.4.15.2.1. Any additions to the Facility sought by the Department, over and above those required to meet the Contractor's obligations under this Contract, including but not limited to expansion of the Facility, shall be carried out by the Contractor at the expense of the Department on mutually agreed terms and conditions. Such agreement will cover the costs of maintenance of the additional facilities also. The Department shall also bear any incremental expenses (along with the percentage fee for the Contractor) required to maintain such additions during the O&M Period. The Department may opt for other sources for construction and maintenance for such additions.

4.4.16 Force Majeure Conditions

1) Power not available at DudhTalai RWPS, MachlaMagra WTP and CWPS.
2) Planned shutdown of PHED.

4.4.17 Department's rights

4.4.17.1. Inspection

4.4.17.1.1. The Department may periodically check the operation of the Facility or designate an organisation of its choice at the cost of Department to carry out inspections of the Facility to satisfy itself that the Contractor is performing its obligations with due diligence.

4.4.17.1.2. Any assistance required for such inspection of the Facility shall be provided by the Contractor at its own cost.

4.4.17.1.3. The Department representative can inspect the facility at any moment during the O&M period.

4.4.17.2. Technical Audit

4.4.17.2.1. The Department has the right to conduct a technical audit of the Facility and to perform any analysis or inspection it deems necessary. Before any such inspection, the Department shall give a prior written notice of three days to the Contractor. The Contractor shall at the Contractor's sole cost and expense provide all assistance the Department requires to complete these inspections. Such audits may cover all or any of the obligations of the Contractor, including but without limitation to,

a) Verification of the system capacity save for normal wear and tear during the O&M Period
b) Verification of the performance standards and useful life of the individual assets of the Facility, save for normal wear and tear during the O&M Period
c) Testing and verification of the water losses
d) Efficiency at which pumps are being operated to ascertain energy consumption.

4.4.17.3. Facility Visits

4.4.17.3.1. At the end of each twelve-month period, or at the initiative of the Department, a visit shall be organised so that both Parties can check the condition of the installations at the Facility.

4.4.17.3.2. A report shall be drawn up to record the opinions of both Parties. The Department reserves the right to call in equipment manufacturers or specialised technicians for these visits.

4.4.17.3.3. These visits shall provide an opportunity for examining maintenance programs and operating procedures and improvements requiring additional investments.

4.4.18 Responsibilities of the Department

4.4.18.1. The Department will provide:

4.4.18.1.1. Power supply to the Facility as per the requirement of the Contractor.

4.4.19 Other Contracts

4.4.19.1. The Contractor shall not delegate its responsibilities hereunder nor subcontract any part of the services to be provided by him hereunder without the prior written consent of the Department. If the Contractor subcontracts its responsibilities hereunder or subcontracts any part of the services to be provided by him hereunder with the consent of the Department, the Contractor shall not be relieved from any liability or obligation under this Contract and the Contractor shall continue to be responsible for the act, defaults or negligence of any sub-contractor as fully as if it were the acts, defaults or negligence of the Contractor, its officers, employees or agents.

4.4.19.2. The period of validity of any contractual commitment for provision of services or material or personnel to the Facility or any subcontract entered into by the Contractor with any party shall not and shall not extend beyond the Termination Date.

4.4.19.3. All such contractual commitments to be entered into by the Contractor should be freely assignable to the Department or to any other contractor, at the discretion of the Contractor.

4.4.19.4. The Contractor cannot create a charge on any assets of the Department or the assets purchased under the Contract.

4.5 BREAK DOWNS

4.5.1 Contractor Action and liabilities

4.5.1.1. In event of break down, resulting in suspension of supplies and also endangering life and / or property, the contractor shall take such action as may be reasonable and necessary at his cost and expenses, to prevent, avoid, or mitigate injury damage and / or loss as soon as possible and rectify the defects / repair the facilities at his own cost, so as to commence the supplies at the earliest possible. The contractor must report all such incidences, indicating the cause and contractor's response thereto, to the Department.

4.5.1.2. The contractor shall utilize its personnel and all his resources to take such action as may be reasonable and necessary in the event of a break down. The contractor must incur all expenditure and take all measures, which are necessary (in accordance with good industrial practice) in case of break down, effecting the facilities and / or to safeguard lives or property.

4.5.1.3. The contractor shall be liable to pay all type of claims arising and raised for any loss of lives / property attributed to such break down, unless such break down has resulted due to force Majeure.

4.5.2 Time for Rectification of Defects:

4.5.2.1. Not limiting to any events listed below the contractor shall be charged for delayed commissioning of the system, after a break down. The reduction in rates for delayed commissioning of events listed below, shall generally be applicable, but can be condoned by the CEO, USCL after considering the grounds for delay. The details of faults and its rectification should be accessible to all concerned departmental persons from anywhere at any time For events not listed below, the CEO, USCL shall decide the reduction in rates on the merit of case and after considering the action taken by the contractor, The decision of CEO, USCL, shall be binding on the contractor.

4.5.3 Consistent Break Downs

4.5.3.1. Notwithstanding to the provision of this clause, in case of consistent “break down” in supplies and with consistent supplies of less than 75% of desired flow in any of the District Metering Area will make the contractor liable of an action as per relevant clauses below.

4.6 TERMINATION

4.6.1 Contractor’s default

4.6.1.1. The Department shall be entitled to terminate this Contract for the following reasons attributable to the Contractor, unless arising as a result of a Force Majeure Event, or any cause related to the obligations of the Department in clause 4.4.2

a) Non-performance of material obligations or failure to perform material obligations under this Contract.
b) Repudiation of this Contract by the Contractor or the evidencing of an intention by the Contractor not to be bound by the terms of this Contract.
c) Appointment of a provisional liquidator in providing for winding up of the Contractor unless such appointment has been set aside within 45 days.
d) The Contractor is ordered to be wound up by a court or files a petition for voluntary winding up except for the purpose of amalgamation or reconstruction provided that such amalgamation or reconstruction does not adversely affect the ability of the amalgamated or reconstructed entity to perform its obligations under this Contract, the successor has assumed in writing unconditional responsibility for the performance of the Contractor's obligations and the technical, financial and operating capability of the successor is satisfactory to the Department.
e) The Contractor abandons the operation of the Facility.
f) Under conditions expressly mentioned in any Clause of this Conditions of Contract for Operation and Maintenance.

4.6.2 Consequences of Termination by Department

4.6.2.1. If the Department, with reasonable grounds, terminates the contract under clause 4.6.1 above, the Secured Advances, and any other sums of the contractor with the Department, shall be fortified and action shall be taken against him as per clause 3 of General Conditions of Contract, if deemed appropriate.

4.7 INDEMNIFICATION

4.7.1 The Contractor to indemnify the Department against the following:

a) The Contractor shall at its own expense make good any physical loss or damage to the Facility occasioned by it in the course of the performance of its obligations under this Contract if and to the extent such loss or damage is caused by the willful misconduct or failure to follow Good Engineering Practices of the Contractor, any sub-contractor or their respective agents or employees.
b) The Contractor shall indemnify, defend and hold harmless the Department and its officers, employees, agents and affiliates against any and all claims of loss, damage and expense of whatever kind and nature, including all related costs and expenses incurred in connection therewith, in respect of personal injury to or death of third parties and in respect of loss of or damage to any third party to the extent that the same arises out of:
    i) Any breach by the Contractor of its obligations hereunder;
    ii) Any negligent act or omission on the part of the Contractor, its subcontractors or their respective agents or employees; and
    iii) Any willful misconduct or breach of statutory duty on the part of the Contractor, its subcontractors or their respective agents and employees.
    iv) Any other event where such indemnification has been expressly mentioned in this Conditions of Contract for Operation and Maintenance.
c) The Contractor shall indemnify, defend and hold harmless the Department and its, officers, employees, agents and affiliates against any and all claims of loss, damage and expense of whatever kind and nature, including all related costs and expenses incurred in connection therewith in respect of the death or injury to any person employed by the Contractor or its subcontractors in connection with the performance of the Contractor's obligations.

4.7.2 The Contractor shall indemnify the Department against all losses and claims in respect of:

a) Death of or injury to any person, or,
b) Loss of or damage to any property (other than the Works).

which may arise out of / in consequence of the Operation and Maintenance of the Facility and the remedying of any defects therein, and against all claims proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto, subject to the exceptions below

i. The permanent use or occupation of land by the Facility, or any part thereof.
ii. The right of the Department to execute the Facility, or any part thereof, on, over, under, in or through any land.
iii. Damage to property, which is the unavoidable result of the execution and completion of the Works, or the remedying of any defects therein, in accordance with the contract.

4.8 Defect liability period

All the provisions of Special conditions of contract Part "B" shall also be applicable during 12 month defect liability period. During defect liability period no payment toward cost of material will be payable however the payment for labour engaged by contractor for Operation of the work during defect liability period shall be payable. The bidder should quote rate for O&M for first year accordingly.

4.9 INTELLECTUAL PROPERTY

4.9.1 All Intellectual Property conceived, originated, devised, developed or created by the Contractor specifically for the Facility or the carrying out of the obligations under this Contract shall vest in the Department as sole beneficial owner and shall be disclosed to the Department upon its the Intellectual Properties coming into existence.

4.9.2 Source code for computer programmers and associated documentation, storage media shall be made available to the Department by the Contractor free of cost

4.9.3 Any Intellectual Property of the Department that is required in connection with the performance of the obligations of the Contractor shall be made available to the Contractor free of charge for the purposes of this Contract alone

4.9.4 The Contractor shall, at its own cost and expense, ensure availability at all times during the Term of this Conditions of Contract for Operation and Maintenance, of any proprietary spares/consumables/equipment that it may have sourced for purposes of ensuring proper functioning of the Facility as per this Conditions of Contract for Operation and Maintenance.

4.9.5 The Contractor shall, as far as practicable, use its best efforts

i. To procure that Intellectual Property owned or developed by third parties and utilised by the Contractor in connection with the performance of its obligations under this Contract for the production of treated water from the Facility and otherwise for the Facility but for no other purpose on reasonable terms
ii. To ensure that no Intellectual Property of a third party is otherwise used in the performance of the Contractor's obligations under this Contract without the approval from the Department.

4.9.6 On Termination of this Conditions of Contract for Operation and Maintenance, the Contractor shall transfer all such Intellectual Property whatsoever to the Department and/or to the Successor Operator at the discretion of the Department.

Chief Executive Officer

Udaipur Smart City Limited

Section-VIC : Contract Forms

Section VI C: Contract Forms

Table of Contents

1. Letter of Acceptance

Letter of Acceptance

[on letterhead paper of the Procuring Entity]

No. . . . . . *D**ated** . . . . . .*

To:. . . . . ***[name and address of the Contractor]*** . . . . . .

Subject: . . . . . ***[Notification of Award for the Works]*** . . . . . .

This is to notify you that your Bid dated . . . . [***date]*** . . . . for execution of the . . . . ***[name of the contract and identification number, as given in the Contract Data]*** . . . . . for the Accepted Contract Amount of the equivalent of . . . . . *[.**amount in numbers and words and name of currency]*** . . . . . ., as corrected and modified in negotiations and in accordance with the Instructions to Bidders has been accepted by …. ***[designation of the Procuring Entity]*** ……... The date of commencement and completion of the Works shall be: ……

You are requested to furnish the Performance Security within …… Days in the form given in the Contract Forms for the same for an amount equivalent to Rupees ……. within …… days of notification of the award valid up to 60 days after the date of expiry of Defects Liability Period and maintenance period, if applicable, and sign the Contract, failing which action as stated in sub-section 2 of section 42 of the Rajasthan Transparency in Public Procurement Act, 2012 and Instructions to Bidders shall be taken.

Authorized Signature: .....

Name and Title of Signatory: Chief Executive Officer,

Udaipur Smart City Limited.

Designation: .....

2A. Contract Agreement (1) With Udaipur Smart City Limited

Contract Agreement

THIS AGREEMENT made the . . . . . .day of . . . . . ., ..., between the Governor of Rajasthan/ . . . . . ***[Udaipur Smart City Limited].*** . . . . . (hereinafter "the Procuring Entity") which expression shall, where the context so admits, be deemed to include his successors in office and assigns, of the one part, and . . . . . ***[name of the Contractor]*** . . . . .(hereinafter "the Contractor"), which expression shall, where the context so admits, be deemed to include his heirs, successors, executors and administrators, of the other part:

WHEREAS the *Procuring Entity* desires that the Works known as . . . . . ***[name of the Contract]*** . . . . .should be executed by the Contractor, and has accepted a Bid by the Contractor for the execution and completion of these Works and the remedying of any defects therein, and for which the Contractor has submitted Performance Security for Rupees ---------- in the form of ----------(For Udaipur Smart City Limited)

The Procuring Entity and the Contractor agree as follows:

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

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.

   a) the Letter of Acceptance;

   b) the Bid of the Contractor as accepted along with the correspondence done on it, if any;

   c) the Special Conditions of Contract/ Contract Data;

   d) the General Conditions of Contract;

   e) the Specifications;

   f) the Drawings*;* and

   g) the Instructions to Bidders and Notice Inviting Bids including Procurement Entity's Requirement

3. In consideration of the payments to be made by the Procuring Entity to the Contractor as indicated in this Agreement, the Contractor hereby covenants with the Procuring Entity to execute the Works and to remedy defects therein (and, if applicable, maintain the Works for a period of -------) in conformity in all respects with the provisions of the Contract.

4. The Procuring Entity hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein (and, if applicable, maintain the Works for a period of -------), the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

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

Signed by	Signed by……
for and on behalf of the Governor/ Palika Entity	.for and on behalf the Contractor
(Chief Executive Officer, Udaipur Smart City Limited)	
in the presence of	in the presence of
Witness, Name, Signature, Address, Date	Witness, Name, Signature, Address, Date

3A. Performance Security

Performance Security

..... [Bank's Name, and Address of Issuing Branch or Office] .....

Beneficiary: ***[Name and Address of Procuring Entity (Chief Executive Officer, Udaipur Smart City Limited] .....***
Date:***.....***
Performance Guarantee No.: ***.....***

We have been informed that . . . . . ***[name of the Contractor]*** . . . . . (hereinafter called "the Contractor") has entered into Contract No. . . . . ***[reference number of the Contract]***. . . . . dated . . . . . .with you, for the execution of . . . . . ***[name of contract and brief description of Works]*** . . . . (hereinafter called "the Contract").

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

At the request of the Contractor, we . . . . . ***[name of the Bank]*** . . . . . hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of Rupees* . . . . . ***[amount in figures]*** . . . . . (.Rupees…… . . . . ***[amount in words]*** . . . . .) ***at the bank branch ____ located at Udaipur,*** such sum being payable upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation(s) under the Contract, without your needing to prove or to show grounds for your demand or the sum specified therein.

The Guarantor agrees to extend this guarantee for a specified period in response to the Procuring Entity's written request for such extension for that specified period, provided that such request is presented to the Guarantor before the expiry of the guarantee.

This guarantee shall expire, no later than the . . . . . Day of . . . . , ... **, and any demand for payment under it must be received by us at this office on or before that date.

. . . . . .

Seal of Bank and Authorised Signature(s)

**** The Guarantor shall insert an amount representing the percentage of the Contract Price specified in the Contract***

***** Insert the date sixty days after the expected completion date, including defect liability period and maintenance period, if any.***

Notes: 1. All italicized text is for guidance on how to prepare this advance payment guarantee and shall be deleted from the final document.

2. The Procuring Entity should note that in the event of an extension of the time for completion of the Contract, the Procuring Entity would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee.

Contract Agreement

THIS AGREEMENT made this .day of . 201.., between Udaipur Smart City Limited, represented by the Chief Executive Officer Ph. 02974-2421255 E-mail: mc_udaipur@rediffmail.com(hereinafter "the Employer"), of the one part and **M/S …….** (herein after "the Contractor"), of the other part:

WHEREAS the *Employer* desires that the Works known as **…….**

and has accepted a Bid by the Contractor for the execution and completion of these Works and the remedying of any defects therein for one year under this contract in conformity with the provisions of the contract in all respect.

The Employer and the Contractor agree as follows:

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

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.

   a) Notice to Proceed
   b) the Letter of Acceptance;
   c) the Bid
   d) the Addenda and Corrigendum
   e) the Special Conditions
   f) the General Conditions
   g) the Specifications;
   h) the Drawings*;*
   i) Instructions to Bidders and Notice Inviting Bids including Procurement Entity's Requirement
   j) the Priced Bill of Quantities and
   k) The Schedule of Supplementary information,

3. In consideration of the payments to be made by the Employer to the Contractor as indicated in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price

or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

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

Signed by	Signed by
Chief Executive Officer, Udaipur Smart City Limited. for and on behalf of the Employer	for and on behalf the Contractor
Witness, Name, Signature, Address	Witness, Name, Signature, Address

Appendix 1 - Insurance Requirements

(A) Types of Insurance to Be Taken Out by the Contractor

In accordance with the provisions of GCC Clause 20, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the types of insurance set forth below in the sums and with the deductibles and other conditions specified. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, such approval not to be unreasonably withheld.

(a) Cargo Insurance

Covering loss or damage occurring, while in transit from the supplier's or manufacturer's works or stores until arrival at the Site, to the Facilities (including spare parts therefore) and to the construction equipment to be provided by the Contractor or its Subcontractors.

Amount [in currency(ies)]	Deductible limits [in currency(ies)]	Parties insured [names]	From [place]	To [place]

(b) Installation All Risks Insurance

Covering physical loss or damage to the Facilities at the Site, occurring prior to completion of the Facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the defect liability period while the Contractor is on the Site for the purpose of performing its obligations during the defect liability period.

Amount [in currency(ies)]	Deductible limits [in currency(ies)]	Parties insured [names]	From [place]	To [place]

(c) Third Party Liability Insurance

Covering bodily injury or death suffered by third parties (including the Employer's personnel) and loss of or damage to property (including the Employer's property and any parts of the Facilities that have been accepted by the Employer) occurring in connection with the supply and installation of the Facilities.

Amount [in INR]	Deductible limits [in INR	Parties insured [names]	From [place]	To [place]

(d) Automobile Liability Insurance

Covering use of all vehicles used by the Contractor or its Subcontractors (whether owned by them or not) in connection with the supply and installation of the Facilities. Comprehensive insurance in accordance with statutory requirements.

(e) Workers' Compensation

In accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.

(f) Employer's Liability

In accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.

(g) Other Insurance

The Contractor is also required to take out and maintain at its own cost the following types of insurance:

Details:

Amount [in INR]	Deductible limits [in INR]	Parties insured [names]	From [place]	To [place]

The Employer shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to GCC Subclause 20, except for the Third Party Liability, Workers' Compensation, and Employer's Liability Insurance, and the Contractor's Subcontractors shall be named as co-insureds under all insurance policies taken out by the Contractor pursuant to GCC Subclause 20, except for the Cargo, Workers' Compensation and Employer's Liability Insurance. All insurer's rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies.

(B) Types of Insurance to Be Taken Out by the Employer – NOT APPLICABLE

The Employer shall at its expense take out and maintain in effect during the performance of the Contract the following insurance policies.

Details:

Amount [in INR	Deductible limits [in INR	Parties insured [names]	From [place]	To [place]

Appendix 2 - Time Schedule

1. Execution Period – 24 months

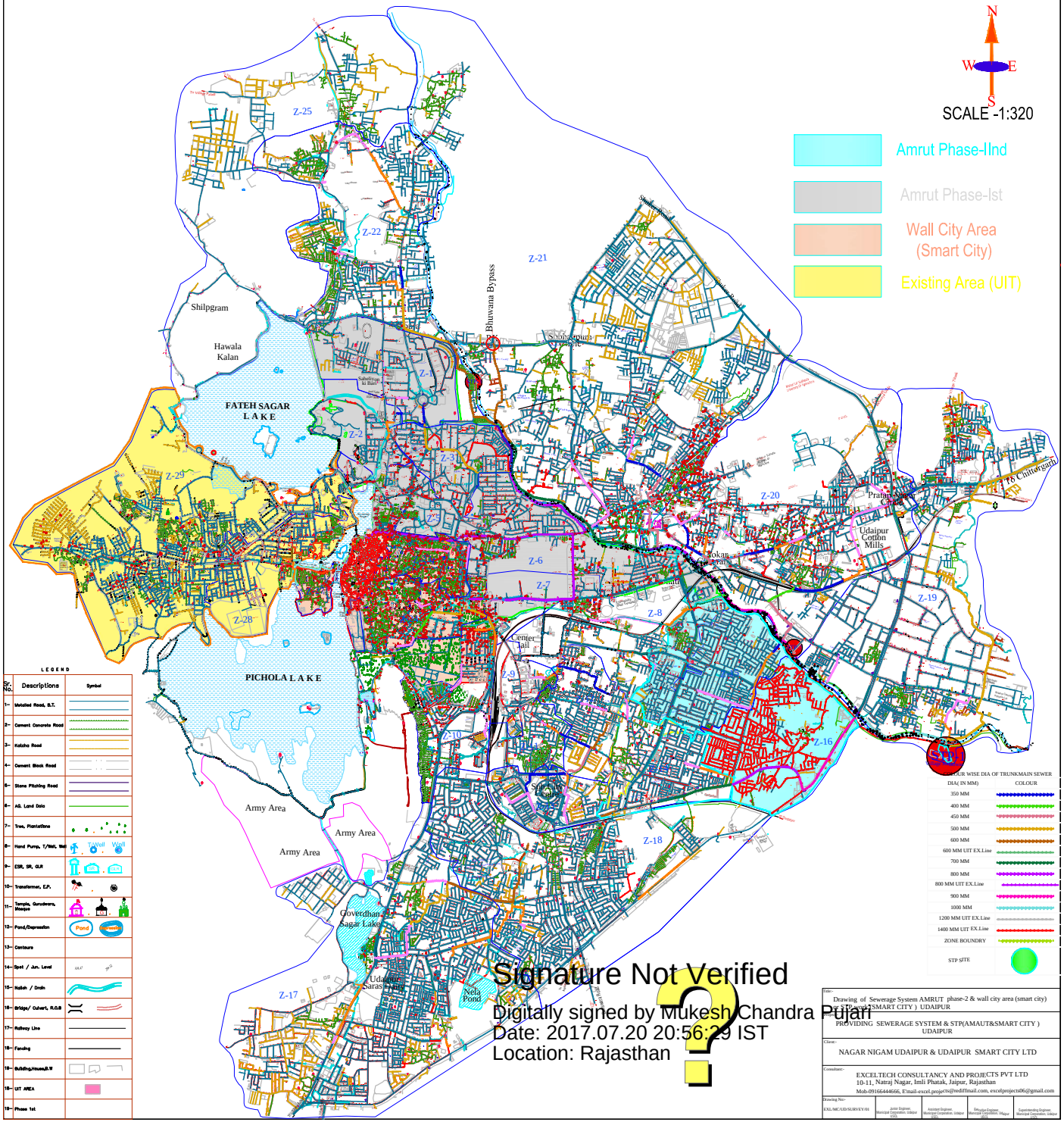
a) Design Period – Six (6) months

b) Execution / Construction period – Eighteen (18) Months

2. Operation and Maintenance period – One Hundred and Twenty (120) Months

The Time Schedule mentioned above is merely indicative. The Contractor will finalise a detailed time schedule to be included in the Contract Agreement

DRAWING OF SEWERAGE SYSTEM AMRUT PHASE-2 & WALL CITY AREA (SMART CITY) OR STP WORK (SMART CITY) UDAIPUR



Signature Not Verified
Digitally signed by Mukesh Chandra Pujari
Date: 2017.07.20 20:56:29 IST
Location: Rajasthan

Title:- Drawing of Sewerage System AMRUT phase-2 & wall city area (smart city) or STP work(SMART CITY) UDAIPUR

PROVIDING SEWERAGE SYSTEM & STP(AMAUT&SMART CITY) UDAIPUR

Client:- NAGAR NIGAM UDAIPUR & UDAIPUR SMART CITY LTD

Consultant:- EXCELTECH CONSULTANCY AND PROJECTS PVT LTD
10-11, Natraj Nagar, Imli Phatak, Jaipur, Rajasthan
Mob-09166444666, E-mail-excel.projects@rediffmail.com, excelprojects06@gmail.com

Drawing No:- EXL/MC/UD/SURVEY/01

Junior Engineer, Municipal Corporation, Udaipur (JEN)
Assistant Engineer, Municipal Corporation, Udaipur (AEN)
Executive Engineer, Municipal Corporation, Udaipur (XEN)
Superintending Engineer, Municipal Corporation, Udaipur (SEN)