

Name of Work: - Latur City Underground Sewerage Scheme under AMRUT 2.0,

Tender Notice No: 10 /2023-24, Tender Reference No: LCMC/WS/108/2023-24 Date 04.01.2024"

CLARIFICATION TO THE POINTS RAISED BY BIDDERS DURING PRE-BID MEETING HELD ON 19-01-2024

DEPARTMETAL POINTS

Sr. No.	PARTICULARS	READ AS
1.	General Conditions of Contact, Clause 67 Page No. 41 & 42. 67. PRICE VARIATION – AUTHORITY Price variation is not applicable to this tender.	67. PRICE VARIATION - AUTHORITY Price variation is (As per Clause 59) applicable to this tender, only for original time period of tender not for extended time period.
2.	Condition of Contract Clause 59: PRICE VARIATION CLAUSE: page No. 107 - 112 Clause 59: PRICE VARIATION CLAUSE:	Annexure -1 attached
3.	6) PRE-QUALIFICATION CRITERIA, Geo Tagging for STP page no. 11 During the period five working days before tender closing, Bidder Should done the site visit to carry out procedure of Geo – Tagging effectively	During the period before tender closing, Bidder should done the site visit to cary out procedure of Geo-tagging effectively. For Geo Tagging Contact person : Shri. Chavan V. S. (Executive Engineer) & Contact Number: 9158632333
4.	DETAILED ITEMWISE SPECIFICATIONS	Volume – II attached.

LATUR CITY MUNICIPAL CORPORATION, LATUR CITY

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BIDDER'S POINTS

S. N.	Section Reference & Ref. Page	Tender Clause Description	Bidder's Query/ Suggestion/ request	Clarification or Reply from LCMC
1	2	3	4	5
A.	PC Snehal Construction	Private Limited, Amdavad, Gujrat, Letter Dated 18 Jan 2024		
1.	Tender Notice /Clause No. 6, Sr. No. 4 Page No. 09	PRE-QUALIFICATION CRITERIA: Trenchless Technology by HDD Method The contractor should have completed successfully the similar work of Trenchless technology by HDD Method of minimum dia. 800 mm dia. & Minimum Length of 560 M.	The Contractor should have completed successfully the Trenchless similar work by any method or by HDD Method of minimum dia. 800 mm dia. & Minimum Length of 560 M.	Accepted. Please read as below - The contractor should have completed successfully the similar work of Trenchless technology by any method (except Push through method) / HDD Method of minimum dia. 800 mm dia. & Minimum Length of 560 M. (For Sewerage Collection and Conveyance network)
2.	Tender Notice /Clause No. 6, Sr. No. 6 i, Page No. 09	PRE-QUALIFICATION CRITERIA: i) Sewerage Treatment Plant – 53 MLD The Contractor shall have experience of Designing, Providing, Constructing, and commissioning successfully Sewerage Treatment Plant based of SBR technology of minimum 26.50 MLD Capacity in a single contract. This STP should be in operation for minimum 2 year giving satisfactory quality of	The Contractor shall have experience of Designing, Providing, Constructing, and commissioning successfully Sewerage Treatment Plant based of SBR technology of minimum 17 MLD Capacity in a single contract. This STP should be in operation for minimum 2 year giving satisfactory quality of effluent as mentioned in the tender / comply latest quality norms prescribed by regulatory body in India.	As per NIT



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	effluent as mentioned in the tender / comply latest quality norms prescribed by regulatory body in India.		
B. Shardha Construction & Corporation Pvt. Ltd., Nanded, Maharashtra, Letter Dated 19 Jan 2024			
1. Tender Notice /Clause No. 6, Page No. 08.	PRE-QUALIFICATION CRITERIA: The Firm / Contractor shall have experience successful completion and commissioning of the works listed below with any Govt. /Semi Govt./ CORPORATION or equivalent organization. The experience of each work should be under single agreement.	The Firm / Contractor shall have experience successful completion and commissioning of the works listed below with any Govt. /Semi Govt./ CORPORATION or equivalent organization. The experience of each work should be under single agreement or more agreement.	As per NIT
2. Tender Notice /Clause No. 6, S.N. 1, Page No. 08 & 09.	PRE-QUALIFICATION CRITERIA: The contractor should have experience in Providing, Lowering, Laying, Jointing, Hydraulic testing and commissioning satisfactorily HDPE (DWC/ Structured -Wall) pipe line minimum dia. 150 mm in Sewerage Scheme or in Storm Water Scheme of length of minimum 73.44 kms in a single contract.	The contractor should have experience in Providing, Lowering, Laying, Jointing, Hydraulic testing and commissioning satisfactorily HDPE (DWC/ Structured - Wall) pipe line minimum dia. 150 mm in Sewerage Scheme or in Storm Water Scheme of length of minimum 65.00 kms in a single contract.	As per NIT
3. Tender Notice /Clause No. 6, S.N. 4, Page No. 09.	PRE-QUALIFICATION CRITERIA: The contractor should have completed successfully the similar work of Trenchless technology by HDD Method of minimum dia. 800 mm dia. & Minimum length of 560 M.	The contractor should have completed successfully the similar work of Trenchless technology by HDD Method of minimum dia. 800 mm dia. & Minimum length of 400 M.	As per NIT

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4. Tender Notice /Clause No. 6, S.N. 6 i, Page No. 09.	PRE-QUALIFICATION CRITERIA: i) Sewage Treatment Plant – 53 MLD The Contractor shall have experience of Designing, Providing, Constructing, and commissioning successfully Sewerage Treatment Plant based of SBR technology of minimum 26.50 MLD Capacity in a single contract. This STP should be in operation for minimum 2 year giving satisfactory quality of effluent as mentioned in the tender / comply latest quality norms prescribed by regulatory body in India.	The Contractor shall have experience of Designing, Providing, Constructing, and commissioning successfully Sewerage Treatment Plant based of SBR/ Conventional/ MMBR technology of minimum 26.50 MLD Capacity in a single contract. This STP should be in operation for minimum 2 year giving satisfactory quality of effluent as mentioned in the tender / comply latest quality norms prescribed by regulatory body in India.	As per NIT
5. Tender Notice /Clause No. 6, S.N. 6 ii, Page No. 10.	PRE-QUALIFICATION CRITERIA: ii) Tie-up agreement with a Technology provider The technology provider should have experience of providing designing, constructing or supervising and commissioning successfully at least 2 sewage treatment plant based on SBR technology proposed by the bidder of minimum capacity 26.50 MLD. The STP should be in operation for minimum 2 years as on date of calling tender and giving satisfactory quality of effluent as mentioned in the tender.	The technology provider should have experience of providing designing, constructing or supervising and commissioning successfully at least 2 sewage treatment plant based on SBR / Conventional/ MMBR technology proposed by the bidder of minimum capacity 26.50 MLD. The STP should be in operation for minimum 2 years as on date of calling tender and giving satisfactory quality of effluent as mentioned in the tender.	As per NIT

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C. JAYNTISUPER Construction Pvt. Ltd., Mehsana, Gujarat, Letter Dated 19 Jan 2024			
1.	Form B.1 Memorandum, Clause d Security Deposit i & ii, page No. 72	d) Security Deposit. Total 4% of estimated cost put to tender or accepted tender cost whichever is higher i) Initial Security Deposit 2% of estimated cost put to tender or accepted tender cost whichever is higher shall be in form of FDR from any Nationalized / Scheduled Bank or Bank Guarantee ii) Balance 2% amount of Security deposit, will be recovered through each Running Bill at the rate of 5% of the gross amount of running bill till the required total amount of Security Deposit is recovered	As per NIT
2.	GENERAL CONDITIONS OF CONTRACT, Clause No. 70, Page No. 42	Mobilization Advance will not be granted.	As per NIT
D. M/s. P. L. Adke, Nashik, Maharashtra, Letter Dated 18 Jan 2024			
1.	Tender Notice / Clause No. 6, Sr. No. 1 b Page No. 09.	PRE-QUALIFICATION CRITERIA: b) RCC Pipes The contractor should have experience in Providing, Lowering, Laying, Jointing, Hydraulic testing and Commissioning satisfactorily RCC pipe line minimum dia. 450 mm	As per NIT

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		in Sewerage Scheme or in Storm Water Scheme of length of minimum 8.94 kms in a single contract.		
2.	Tender Notice /Clause No. 6, Sr. No. 2 Page No. 09.	PRE-QUALIFICATION CRITERIA: Rising Main The contractor should have experience of Lowering, Laying, Jointing, and satisfactory hydraulic testing and commissioning in sewerage scheme satisfactorily DI pipe line work of minimum dia. 600 mm and length of minimum 1.41 Km in a single contract.	Kindly allow water supply scheme instead of sewerage scheme as the process of lowering, laying and jointing of D.I. pipe is same for sewerage line and water supply scheme.	As per NIT
3.	Tender Notice /Clause No. 6, Sr. No. 4 Page No. 09.	PRE-QUALIFICATION CRITERIA: Trenchless Technology by HDD Method The contractor should have completed successfully the similar work of Trenchless technology by HDD Method of minimum dia. 800 mm dia. & Minimum Length of 560 M.	Kindly allow push through method instead of trenchless technology by HDD method of minimum dia. 800 mm dia. & minimum length of 215 meter.	As per NIT
4.	Tender Notice /Clause No. 6, Sr. No. 5 Page No. 09.	PRE-QUALIFICATION CRITERIA: i) Sewage Treatment Plant – 53 MLD The contractor shall have experience of Designing, Providing, Constructing, and commissioning successfully Sewerage Treatment Plant based of SBR technology of minimum 26.50 MLD Capacity in a	Kindly allow water treatment plant instead of sewerage treatment plant.	As per NIT



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6. General		Specification of SBR process and component are not specified, hence please specify.	<table border="1"> <thead> <tr> <th>Sr. No.</th><th>Parameters</th><th>Values Treatment</th><th>after</th></tr> </thead> <tbody> <tr> <td>1.</td><td>pH</td><td>5.5 to 9.0</td><td></td></tr> <tr> <td>2.</td><td>BOD₅</td><td>≤ 10 mg/l</td><td></td></tr> <tr> <td>3.</td><td>COD</td><td>≤ 50 mg/l</td><td></td></tr> <tr> <td>4.</td><td>TSS</td><td>≤ 10 mg/l</td><td></td></tr> <tr> <td>5.</td><td>TP</td><td>≤ 2 mg/l</td><td></td></tr> <tr> <td>6.</td><td>TN</td><td>≤ 10 mg/l</td><td></td></tr> <tr> <td>7.</td><td>NH₃-N</td><td>≤ 1 mg/l</td><td></td></tr> <tr> <td>8.</td><td>Faecal Coliform</td><td>≤ 100 MPN/100 ml</td><td></td></tr> </tbody> </table>	Sr. No.	Parameters	Values Treatment	after	1.	pH	5.5 to 9.0		2.	BOD ₅	≤ 10 mg/l		3.	COD	≤ 50 mg/l		4.	TSS	≤ 10 mg/l		5.	TP	≤ 2 mg/l		6.	TN	≤ 10 mg/l		7.	NH ₃ -N	≤ 1 mg/l		8.	Faecal Coliform	≤ 100 MPN/100 ml	
Sr. No.	Parameters	Values Treatment	after																																				
1.	pH	5.5 to 9.0																																					
2.	BOD ₅	≤ 10 mg/l																																					
3.	COD	≤ 50 mg/l																																					
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6.	TN	≤ 10 mg/l																																					
7.	NH ₃ -N	≤ 1 mg/l																																					
8.	Faecal Coliform	≤ 100 MPN/100 ml																																					
			Cleared in Departmental point Sr. no. 5																																				


 Executive Engineer
 Latur City Municipal Corporation
 Latur


 Commissioner
 Latur City Municipal Corporation
 Latur

Clause 59 : PRICE VARIATION CLAUSE:

If during the operative period of the contract as defined in condition (1) below, there shall be any variation in the Consumer Price Index (New Series) for Industrial workers for _____Centre as per the Labour Gazette published by the Commissioner of Labour, Govt. of Maharashtra &/or in the Wholesale Price Index for all commodities prepared by the Office of Economic Adviser, Ministry of Industry, Govt.

Contractor

No. of correction

Executive Engineer

of India or in the price of petrol/oil & lubricants & major construction materials like bitumen, cement, steel, various types of metals pipes etc. then subject to the other conditions mentioned below, price adjustment on account of

- i. Labour component
- ii. Material component
- iii. Petrol, oil & lubricant components
- iv. Cement components
- v. HYSD & mild steel components
- vi. Cement component
- vii. CI & DI pipes component

Calculated as per the formula hereinafter appearing, shall be made. Apart from these, no other adjustment shall be made to the contract price for any reason whatsoever. Component percentage as given below is as of the total cost of work put to tender. Total of labour, material & POL components shall be 100 & other components shall be as per actuals.

i. Labour component	(K ₁)%
ii. Material component	(K ₂)%
iii. Petrol, oil & lubricant components	(K ₃)%
iv. Cement components	
v. HYSD & mild steel components	
vi. Cement component	
vii. CI & DI pipes component	

Note- if Cement, steel, bitumen, CI & DI pipes are supplied on Schedule-A, then respective component shall not be considered. Also, if particular component is not relevant same shall be deleted.

1) Formula for Labour components:

$$V_1 = 0.85P \times \frac{K_1}{100} \times \frac{L_1 - L_0}{L_0}$$

Where

V₁= Amount of price variation in Rupees to be allowed for Labour components

P= Cost of work done during the Quarter under consideration minus the cost of cement, HYSD and mild steel, Bitumen, CI & DI pipes calculated as the basic star rates as applicable for the tender, consumed during the quarter under consideration.

K_1 = Percentage of LABOUR component as indicated above

L_0 = Basic Consumer Price Index for ----- center shall be average consumer price index for the preceding months in which the last date prescribed for receipt of tender falls.

L_1 = Average consumer price index for ----- center for the quarter for the consideration.

2) Formula for Material components:

$$V_2 = 0.85P \times \frac{K_2}{100} \times \frac{M_1 - M_0}{M_0}$$

Where

V_2 = Amount of price variation in Rupees to be allowed for Material components

P = Same as work out for labour component

K_2 = Percentage of Material component as indicated above

M_0 = Basic Wholesale Price Index shall be average Wholesale price index for the preceding months in which the last date prescribed for receipt of tender falls.

M_1 = Average wholesale price index for the quarter under consideration

3) Formula for petrol, oil & lubricant components

$$V_3 = 0.85P \times \frac{K_3}{100} \times \frac{P_1 - P_0}{P_0}$$

Where

V_3 = Amount of price variation in Rupees to be allowed for POL components

P = Same as work out for labour component

K_3 = Percentage of petrol, oil & lubricant components component as indicated above

P_0 = Average price of HSD at -----, during the preceding months in which the last date prescribed for receipt of tender falls.

P_1 = Average price of HSD at -----during the quarter under consideration

4) Formula for Bitumen components

$$V_4 = Q_B(B_1 - B_0)$$

Where

V_4 = Amount of price variation in Rupees to be allowed for Bitumen components

Q_B = Quantity of bitumen (Grade) in metallic tonnes used in the permanent works & approved enabling works during the quarter under consideration

B_1 =Current, average ex-refinery price per metric tone of bitumen (Grade) under consideration excluding Goods and service tax during the quarter under consideration.

B_0 = Basic rate of bitumen in Rupees per metric tonnes as considered for working out value of P or average ex-refinery price in Rupees per metric tonne excluding good and service tax of bitumen for the grade of bitumen under consideration during prevailing precending the month in which the last date prescribed for receipt of tender fall whichever is higher.

5) Formula for HYSD & mild steel components

$$V_5 = S_0 \times \frac{(Sl_1 - Sl_0)}{Sl_0} \times T$$

Where

V_5 = Amount of price variation in Rupees to be allowed for HYSD / mild steel components

S_0 = Basic rate of HYSD / mild stel in rupees per matric tonne excluding GST as considered form working out value of T.

Sl_1 = Average steel index as per RBI bulletin during the quarter under consideration

Sl_0 = Average of steel index as per RBI bulletin for the precending month in which the last date prescribed for receipt tender falls.

T = Tonnage of steel used in the permanent works for the quarter under consideration

6) Formula for cement components

$$V_6 = \left\{ \frac{C_0(Cl_1 - Cl_2)}{Cl_0} \right\} T$$

Where

V_6 =Amount of price escalation in Rupees to be allowed for cement components

C_0 = Basic rate of cement in Rupees per metric tonnes excluding GST as considered for working out value of P.

Cl_1 = Average cement index published in the RBI bulletin for the quarter under consideration

Cl_0 =Average of Cement Index published in the RBI Bulletin for the preceding the month in which the last date prescribed for receipt of tender falls.

T=Tonnage of cement use din the per man entworks for the quarter underconsideration.

7) Formula for CI/DI pipe Component:

$$V_7 = Q_d \times (D_1 - D_0)$$

Where

V_7 =Amount of price escalation in Rupees to be allowed for CI/DI pipe component.

D_0 =Pig iron basic price in Rupees per tonne excluding GST considered for working out value of P.

D_1 =Average pig iron price in Rupees per tonne during the quarter underconsideration (Published by the Institute of Indian foundrymen)

Q_d =Tonnage of CI/DI pipes used the works during the quarter under consideration.

The following gconditions shall prevail:

i) The operative period of the contract shal lmean the period commencing from the date of the work order issued to the contractor & ending on the date on which the time allowed for the completion of work specified in the contract for work expires, taking in to considering the extension of time, if any, for completion of the work granted by Engineer under the relevant clauses of theConditions of Contract in cases other than those where such extension is necessitated on accountof default of the contractor. The decision of Engineer as regards the Operative period of thecontract shall be final & binding on the contractor. Where any compensation for liquidated damages

is levied on the contractor on account of delay in completion or inadequate progress under the relevant contract provisions, the price adjustment amount for the balance of work from the date of levy of such compensation shall be worked out by pegging the indices L_1 , M_2 , P_1 , B_1 , Sl_4 , Cl_1 , D_1 to levels corresponding to the date from which such compensation is levied.

ii) This price variation clause shall be applicable to all contracts in B1, B2 and SBD forms but shall not apply to piece works. The price variation shall be determined during each quarter as per formula given above in this clause.

iii) Price variation under this clause shall not be payable for the extra items required to be executed during the completion of the work & also on the excess quantities of items payable under the provision of Clause 41/37/38 of the contract form B1/B2/SBD respectively. Since the rates payable for the extra items or the extra quantities under Clause 41/37/38 are to be fixed as per the current DSR or as mutually agreed to yearly revision till completion of such work. In other words, when the completion/execution of extra items as well as extra quantities under Clause 41/37/38 of the Contract Form B1/B2/SBD extends beyond the operative date of the DSR, then rates payable for the same beyond that date shall be revised with reference to the current DSR prevalent at that time on year to year basis or revised in accordance with mutual agreement thereon, as provided for in the contract, whichever is less

iv) This clause is operative both ways i.e. if the price variation as calculated above is on the plus side, payment on account of the price variation shall be allowed to the contractor & if it is on the negative side, implementing agency shall be entitled to recover the same from the contractor & the amount shall be deductible from any amounts due & payable under the contract.

v) To the extent that full compensation for any rise or fall in costs to the contractor is not entirely covered by the provisions of this or other clauses in the contract, the unit rate & price included in the contract shall be deemed to include amount to cover the contingency of such other actual rise or fall in costs.

vi) Calculation for working out escalation payment on account of material, labour & POL will be restricted to 2 digits only.

DETAILED ITEMWISE SPECIFICATIONS

DETAILED ITEMWISE SPECIFICATIONS

SUB WORK NO. 1: - WORKING SURVEY

Item No.1: - Carrying out topographical survey, contouring of all terrain(all types), road, bridge and building works by using Electronic Total Station surveying instruments (3 second least count) with its all accessories tools, plants including preparing necessary plans such as L-Sections cross sections, contouring, topographical detail survey plans as directed by processing data on computer, preserving processed data on CD's or any other advanced type computer hardware including all manpower i.e. electronic total station operator, computer engineer, trained supervisor, skilled labours, machineries such as electronic total station with its accessories, computer with latest configuration, materials such as stationary required for printing processed data, plotting drawings of required sizes, submission of processed data and plans in properly bound book as directed etc. complete

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for Km. basis.

Item No.2: - Taking trial bores 75 to 100 mm for 53.0 to 88.9 mm core dia over burden (by diamond drilling machine) such as soil of all sorts, soft murum, hard murum and boulders and in soft rock including all materials such as casing pipes and accessories oil, grease, steel, rods, and such other materials as required (including conveying the material to site of work) . Preserving the loose sample in glass jar and core sample serially on site of work and conveying the same to HQ of concerning office as directed. a) over burden 0 to 50 meter

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one Meter basis.

Item No.3: - Taking trial bores 75 to 100 mm for 53.0 to 88.9 mm core dia over burden (by diamond drilling machine) such as soil of all sorts, soft murum, hard murum and boulders and in soft rock including all materials such as casing pipes and accessories oil, grease, steel, rods, and such other materials as required (including conveying the material to site of work). Preserving the loose sample in glass jar and core sample serially on site of work and conveying the same to HQ of concerning office as directed. Other Rock with diamond drill. 0 to 50 metre

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one Meter basis.

Item No.4: - Conveying the boring machine and engine and all its accessories etc. to the site of the work and back including loading unloading etc. complete. (Note - Distance to be measured from the station of boring machine engine etc. of district headquarters to site of the work by short route).

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one KM basis.

Item No.5: - Shifting boring plant with all its components and reinstalling the same at the directed place including all its charges etc. complete

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one Shift basis.

Item No.6: - Providing detailed reports of the inspection logging of drilled hole by observing visual description of data as per depth, thickness of layer, type of sample, wash sample, bore recovery type of drill etc. complete.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for No. basis.

Item No.7: - Providing detailed geological reports of proposed site by maintaining geotechnical investigation of structure stratification collecting soil, rock and ground water samples for laboratory tests to arrive the foundation design parameters. Rock properties such as type of rock, jointing fractures, etc. complete with suggestion about the site foundation and remedies.

Mode of Payment: -

The item shall be measured and paid on one Report basis.

Item No.8: - Preparation of AutoCAD drawing with colour print for Building / Bridge / Road/ CD Works in required size etc. complete.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid on No. basis.

Item No.9: - AutoCAD drawing with colour print out for Building / Bridge / Road/ CD Works in required size etc. complete.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid on No. basis.

SUB WORK NO. 2a & 2b: - COLLECTION AND CONVEYANCE SYSTEM (Zone I & Zone II)

Item No.1: - Excavation for Foundation/ pipe trenches for works of Sewer Pipeline, gravity mains, and for all types of pipe materials in all types of Soil, earthy or sandy materials, soil of all type of sand, clay mud, Soft Murum, soft average or hard murum, Boulders, all type of disintegrated rock, shingles, brick bats, isolated boulders of any size, all type of rock including soft, hard and manjara rock by permissible and suitable methods such as Controlled blasting, chiselling, wedging, line drilling and or by use of mechanical means including excavation in all type of road surfaces such as WBM, Asphalt, concrete road, including trimming the surface by chiselling whenever required including removing the roots of trees met with during excavation levelling the bed and keeping it clean and dry by dewatering and making ready for lowering, laying of pipe, manual dewatering, excluding backfilling including removing the excavated stuff up to a distance of 50 m beyond the work site and stacking the same as directed by Engineer in charge etc. Complete for lift as mentioned below. **(Lift 0 to 1.5 M)**

Item No. 2: Excavation for foundation / pipe trenches in hard rock and concrete road by chiselling, wedging, line drilling, by mechanical means or by all means other than blasting including trimming and levelling the bed, removing the excavated material upto a distance of 50 metres beyond the area and lifts as below, stacking as directed by Engineer-in-charge, normal dewatering, excluding backfilling, etc. complete by all means. **(Lift 1.50 to 3.0 M), (Lift 3.00 to 4.50 M), (Lift 4.50 to 6.0 M), (Lift 6.00 to 7.50 M).**

1.1. General

The specifications contained in the standard specification volume IIInd published by Public Works and Housing Department, Govt. of Maharashtra, Chapter Bd. A (1, A-2, A-3, A-4 & A-6 etc. on page No. 259) (Red Book) shall apply.

The excavation shall be done to the required depth and section as per design drawing and as directed by Engineer-in-Charge. Extra depth shall be made up clear with concrete or other suitable materials as directed by Engineer-in-charge. At the cost of contractor. The excavated material shall be not be placed nearer than 300 m. from the edges of excavated portion. No Compensation shall be admissible to the contractor due to any delay such as permission etc. After refilling of the trenches, the balanced stuff should be disposed off as directed. Refilling and disposal will be paid separately in relevant items if Schedule 'B'.

1.1. Site Clearance

The area to be excavated shall be cleared off. All trees and bushes and rubbish and other objectionable materials removed shall be burnt or disposed off as directed by the Engineer-in-Charge. The cost of such clearing shall be deemed to have been included in the rates accepted for different items under excavation. During excavation, if masonry, concrete structure roots of trees etc are met with the same shall be removed without extra cost. The loss to public or private utility services such as telephone or electric cables / water mains or such other if comes across the trenches, shall have to be made good at the cost of the contractor. The permission for such crossing if required from the competent authority shall be obtained through Department. However, delay in obtaining such permission shall not be considered as cause of delay for the works and no compensation shall be admissible to the contractor due to such delay.

1.1. SHORING AND STRUTTING

The item includes all shoring and strutting that may be required. On no account the width of trenches more than these mentioned here in after shall be measured. If excavation width more than the specified is required for the purpose of keeping machinery, steeping due to lose material or for any other reasons the same shall be at the Contractors cost.

1.1. Fencing, Lighting and Watching: -

The contractors shall make all proper arrangement for protecting the work by means of fencing, watching, and lighting at night, as directed by the Engineer-in-charge. The post of fencing shall be of timber, securely fixed in the ground not more than 3m. apart, and they shall not be less than 75 mm in diameter or less than 1.2 m. above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 450 mm above the surface of the ground and each shall be from 50 mm to 70 mm in diameter and sufficiently long to run from post to post, to which they shall be bound with strong rope. The method of projecting not be allowed on any account. All along the edges of the excavated trenches a bank of earth about 1.20 m high shall be formed where required by the Engineer-in-charge for further protection. Proper provision shall be made for lighting at night and watchman shall be kept to see that this is properly done. In the event of the contractors not fully complying with the provisions of these clauses. The Engineer-in-charge may put up a fence or improve the fence already put up or provide or improve the lighting or adopt such measures as he may deem necessary without prior intimation to the contractor and all the cost of such procedure as may be adopted by the Engineer-in-charge, shall be borne by the contractor.

In addition to the normal lighting arrangements, the contractor shall be provided wherever a sewer work is in progress, battery operated linking lights (6 Volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The contractor shall also provide and display special boards painted with fluorescent paints indicating the progress of the work along a particular road.

The items of excavation are including necessary lighting at night at suitable intervals, but not more than 15 meters along the excavated trenches and at all crossing and barricading the same by fencing so as to avoid the accident. Chowkidars shall be employed at place where the trenches cross over any traffic road to caution the vehicles and pedestrians etc. The arrangements shall be maintained till completion of work and at the cost of the Contractor.

1.1. Alignment and levels. :-

Before the excavation of trench is commenced, sight rails shall be erected at every 30 m. and at all points of change of direction, gradient and at ends. The excavation work shall be proceeded by a joint survey along with alignment of the main, to obtain ground level at every 30 m. or less distance. Temporary Bench Marks shall be constructed at every 300 m. distance along the alignment and shall be maintained till the completion of the work. All labour and materials for the survey work of fixing Bench Marks etc. shall be provided by the contractor at his own cost. Since the lines to be laid are drainage lines., the grade and level are very important factors. Those shall be maintained very carefully. For any mistakes in survey the Contractor is fully responsible. He should not lay the pipes, unless the alignment is thoroughly checked by the Engineer-in-Charge or his authorized representative who is empowered to sign the work order book in token of checking the exact grade and level of the trench excavation.

Excavation at random places shall not be measured by the PCMC's Engineer. Any non- technical practices during the excavation of the contracted work shall be viewed very seriously by the PCMC and a note to that effect will be recorded against the Contractor in his name.

1.1. Depth and Grades of trenches: -

The trenches shall be excavated to the required grades and depth as shown on approved drawings or as directed by the Engineer-in-charge. If not so, the payment for the item will not be paid to the Contractor. The depths of excavation and the level of the pipe inverts shall be checked by means of boning rods of suitable lengths. Additional depths if required to be excavated for pits for sockets, collars, specials, joints, and for any other working facility shall not be measured and paid separately. The minimum cover above the pipe shall be 0.90 m.

The bottom of trench shall be leveled both longitudinally and transversely or stepped as directed by Engineer-in-charge. The Contractor shall notify the Engineer when the trenches are ready for bedding so that the Engineer can inspect and record the depth. Only on explicit approval by Engineer, the bedding shall be provided by the Contractor. If any public utility i.e., electrical cable, telephone cable, water connections, sewer connections, gutter damage etc. then same will be rectified by contractor at his own cost.

1.1. Width of trenches for excavation: -

The maximum width of trench allowable for different diameter of pipe sewer is given in the table below. The offset for width is allowable for every additional depth of trenches as tabulated for soft strata only.

The sides of the trenches shall be as nearly vertical as possible. The bottom of the trench shall be flat side to side.

Sr. No.	Dia. of Pipe	Lift 0.0 m. to 1.50 m.	Lift 1.5 m. to 3.00 m.	Lift 3.00 m. to 4.50 m.	Lift 4.50 m. to 6.00 m.
1	150 mm to 300 mm	1.00 m.	1.30 m.	1.60 m.	2.00 m.
2	400 mm	1.10 m.	1.40 m.	1.70 m.	2.05 m.
3	450 mm	1.15 m.	1.45 m.	1.75 m.	2.10 m.
4	500 mm	1.20 m.	1.50 m.	1.80 m.	2.10 m.
5	600 mm	1.30 m.	1.60 m.	1.90 m.	2.20 m.
6	700 mm	1.40 m.	1.70 m.	2.00 m.	2.30 m.
7	800 mm	1.50 m.	1.80 m.	2.10 m.	2.40 m.
8	900 mm	1.60 m.	1.90 m.	2.20 m.	2.50 m.
9	1000 mm	1.70 m.	2.00 m.	2.30 m.	2.60 m.
10	1100 mm	1.80 m.	2.10 m.	2.40 m.	2.70 m.
11	1200 mm	1.90 m.	2.20 m.	2.50 m.	2.80 m.

The maximum width as mentioned in the table of different depth of trenches or the actual width whichever is less shall be taken into account for measurement and payment. No extra width is allowable due to large quantity or big boulders met with in the trenches. Dressing and consolidation of the trenches.

The bed of the trenches shall be well rammed before laying of the murum or sand for bedding hollows, if any, shall be filled with murum duly rammed and watered to required level and grade at cost of the Contractor.

The contractor shall properly assess the work involved in above description and quote accordingly. The Executive Engineer's decision regarding any of the issue of scope of work here in and rates payable shall be final, conclusive and binding on contractor.

Any damages to the telephone cables / electrical cables shall be borne by the contractor, if demanded by the concerned authority. The cost of damages shall be directly paid by the Executive Engineer to the authority and such amounts shall be recoverable from the contractor through his due payments/ security deposits. In case water mains is damaged by the contractor during execution and quantity of water is wasted due to his negligence, that amount of wastage of water shall be recoverable from the contractor as per the PCMC's water rate prevailing at the time of execution through his running bill.

For excavated width whichever is less shall be recorded and paid for. Extra widths for pits at sockets, collars, specials, joints, construction and also for working liabilities shall neither be measured nor paid for. However, excavation required for providing and casting fixity block, thrust blocks, encasing etc. will be measured and paid for under relevant item of excavation. The pits for welding joints will also be paid under relevant item of excavation.

1.1. CLASSIFICATION OF MATERIALS IN TRENCHES

The exact classification of the strata met with during the excavation shall be done by the representative of Engineer-in-Charge and accordingly measurement shall be recorded under different items of excavation provided under Annexure to Clause-38 of tender for the purpose of excess quantity. In case of any, dispute regarding classification of strata, the decision of Engineer-in-Charge shall be final and binding. The strata classifications and its quantity shown are indicative only. The Contractor therefore, shall carry out his own assessment regarding the strata at different depth along the alignment, before submission of the tender.

1.1. Disposal of Surplus Stuff: -

The contractor shall carefully excavate the road surfaces and stack the materials obtained from for road surface cutting systematically for selectively reusing the same for remarking the road. At times it may be necessary for the contractor to remove the excavated stuff to a suitable destination away from the excavation work. This stuff stacked as directed within 50 m. lead shall be brought back for refilling by the contractor without any extra payment on this account.

The excavated stuff remaining in balance after refilling and remaking of road shall be conveyed, unloaded and leveled by the contractor at a destination as directed by Engineer-in-charge within a radius of 5 Kms from site of work. The same shall be paid to the contractor separately under relevant item of Schedule 'B' If it is seen that the surplus excavated stuff is being sold by the agency the agency will be penalized as decided by the Engineer-In-Charge.

1.1. EXCAVATION BY CHISELLING MECHANICAL MEANS

(In Hard Strata) Excavation in hard strata shall be done by chiseling, wedging or line drilling as specified any mechanical all means or ordered by the Engineer. The excavation refers to excavation generally for foundation, wet or dry, in hard rock by chiseling, wedging or line drilling and shall comply with the specifications.

1.1. MODE OF MEASUREMENT AND PAYMENT

The excavation shall be measured in Cubic meters only. Dimensions shall be measured correct to two decimals of meter and quantity shall be calculated to two places of Decimal of Cubic meters. The item mentioned in Schedule-B in which includes disposing excess excavated material remained after refilling will not be paid separately for disposing excavated material.

Note: - No payment will be made unless final depth of excavation is reached.

1.1. Dewatering

No distinction shall be made as to whether the material being excavated is dry, moist or wet. The item also includes bailing out of water manually to keep the trenches reasonably dry for all further works of concerning, lowering, laying & Jointing and testing of the pipe line till the completion of the work. Separate item of Dewatering is incorporated in the tender, if any ground water sources are met during excavation. No extra over the tendered provision shall be paid to contractor for this reason on any account.

Item No.3: - Dewatering the excavated trenches and pools of water in the building trenches, pipeline trenches, well works, by using pumps and other devices including disposing of water to safe distance as directed by Engineer-In-Charge (including cost of machinery, labour and fuel) etc. complete.

The item shall comply as per standard specification No. Bd-A-9, on page No. 261.

This item is provided for Dewatering during excavation of entire work when it is not possible to bail out the water manually, the item includes all machinery, fuel, labour etc. The contractors shall provide all dewatering pumps, engines and machinery required to keep the trenches dry laying sewer lines, drains or foundations and all other excavations shall be clear of water, whether sub-soil water, storm water leakage from tanks, wells drains, sewers water, mains, tide water etc. so that there may be no accumulations of such water. And that no setting out may be done the pumping shall be continued so long after execution of any portion of work and repeated so after as the Engineer-in-charge may determine to be sufficient at any particular time, or he may himself supply pumps and power at contractor expenses, so he may stop the work all together until he is satisfied and also impose a fine upon the contractor. It is the contractor's responsibility to keep dewatering machinery in up to date working condition to keep the trenches dry for laying pipes or for placing the concrete.

Mode of Payment: - 25% payment will be released after completion of 50% work & remaining 75% shall be made after completion of Work, in a zone. The necessary documents shall be submitted by the agency. The provision of dewatering is on lumpsum basis for whole items of the sub work No.1 to be executed. However, the payment will be made, in proportionate with the quantity of work executed. No extra payment will be made if quantity of items is increased. Maximum quantity of dewatering will be considered for trunk sewer line in nalla bed and rest of the quantity will be considered for laterals, as directed by Engineer-in-charge.

Item No.4: - Open timbering in trenches of depth more than 1.5m for shoring & strutting including use of & waste of all necessary timber works including walling, struts, open pulling boards/horizontal sheeting, runners etc. as may be necessary & fixing & removal complete. (Measurements to be taken of the face area timbered)

Providing and fixing approved type of shoring etc. complete.

The item shall comply as per relevant item of Schedule 'B' as per standard specification of latest Edition of Red Book and N.B.O. Item No.4, 15-page No. 59. This item shall be executed with prior permission of Engineer.

When the depth of trench required to be excavated is more than 1.5 M. and the strata met with is unstable, timbering of trenches shall be done to prevent caving or collapse of side walls. Precautions to prevent extensive caving shall be adopted for minimizing danger when the depths exceed 1.5 m as stated above. Only in such cases, the timbering shall be done from top to bottom of the trench.

The sheeting and the other members like polling Boards, struts walling shall be strong enough to withstand against the soil pressure. Timbering shall be done only at the required places. The location of timbering is required to be carried out shall necessarily be approved and finalized by competent authority. Timbering unnecessary provided shall not be measured and paid for. The contractor shall take photographs of timbering work done by him at his own cost and shall be submitted to the Department from time to time.

Shoring: -

Wherever shoring may deem necessary by the Engineer-in-charge the contractor shall provide the same in the best possible manner with the best materials and to the satisfaction of the Engineer-in-charge. The contractor shall employ such kinds or kinds of shoring as the Engineer-in-charge any consider the exigencies of the work of require and it is to be distinctly understood that the work „shoring“ is to comprise all clauses of such work and all appliances and appurtenances including polling boards, sheet piling of runners (Whether the joints be butt, groove and tongue, feather edge and groove, birds mouth and double splay, rebated or otherwise), together with walling struts prop, point blank shores, blocks, wedges, iron dog, bolts, screws, nails and everything that may be required for due execution of the work. No part of the shoring shall at any time be removed by the contractor without obtaining permission from the Engineer-incharge. While taking out shoring plank the hollows if any, formed must simultaneously be filled in with of earth well rammed with rammers and with water.

Shoring left in trenches: -

The Engineer-in-charge may order portions of shoring to be left in the trenches at such places, where it is found absolutely necessary to do so as to avoid any damages which may be caused to building cables, gas-mains water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. No extra payment shall be made to the contractor on account of shoring left in trench.

Engineer-in-charge may put up or improve shoring: -

In the event of the contractors not complying with the provisions of this contract in respect of shoring, already put up or adopt such other measures as he may deem necessary and all the cost of such procedures adopted by the Engineer-in-charge shall be borne by the contractor.

Liability for Timbering: -

a) No work done by the Engineer-in-charge or his workmen for the fact that the timbering has complied with his specification shall absolve the contractor from his responsibility and he will be responsible for making good any damage caused as a result of the timbering failing to give proper support to the sides of the Excavation.

b) The timbering to the sides of excavation for structures shall be carried out in such a way that there is no obstruction caused to the work. The supporting struts and walling shall be removed by the contractor in stages to suit the progress of work.

c) If the Engineer-in-charge is not satisfied that the standard of timbering is equal to that the sides of the excavation have not been secured in a manner to render such excavating safe for working, he may, one hour after notifying the contractor or his representative in writing, employ his own men to alter the timbering and the cost of such workman and materials employed shall be paid for by the contractors.

Contractor's responsibility for secure shoring and or all damages: -

The contractors will be held responsible for providing secure shoring and for adopting every other precaution which may be necessary or proper for protecting and building which may be damaged or be liable to damage by the excavation of any trench or otherwise by the excavation of the works in the vicinity of such building. If the Engineer-in-charge shall require the adoption of any special or extra measures or precautions the contractors shall forth with adopt & supply the same but this proportion is not to be read or understood as in any degree of relieving the contractors from responsibility or from liability under relevant clause contract, in respect of claims made against the department by for loss or damage which may be caused to any such building by the excavation of any of the works or otherwise. After the work is completed near buildings, the contractors shall remove any shoring and make good any cutting out or other damage that may have been done.

Mode of Payment: -

The item shall be measured and paid for one square meter basis. The area shall be calculated by considering the length and height of open timbering and shoring provided for each side of trench separately. The timbering shall be paid to the extent of 85% only after its objective of protecting the excavation till the lowering, laying, jointing, testing of the sewer line is completed and the section is refilled. 15% payment shall be made after the zone.

Item No.5: - Filling in plinth and floors, murum bedding in trenches with approved murum excavated materials from foundation in 15 cm to 20 cm layers including watering and compaction etc. complete.

For bedding, only murum from excavated material as approved by Engineer-in-charge. Shall be used. Bedding shall be done before laying of pipes to the desired grade, line and level with necessary watering and compaction etc. complete. This shall be executed when B.C. Soil and hard rock met at the bottom of trench for certain length. The filling in trench around the pipes and 0.30 m on top of pipe line shall be done in B.C. Soil and rock as directed. The item includes lead beyond 0.50 kms. And lift as required. If the approved quality of murum is available within 5 Kms. Lead at any of work, the same shall be used for bedding and refilling as directed by Engineer-in-charge. The payment shall be made as per relevant item No.5 of disposal in Schedule 'B' this can be possible only, if the execution of work is done simultaneously at more site.

Mode of Payment: -

The item shall be measured and paid for one Cubic meter basis.

Item No.6: - Filling in plinth and floors / trenches with contractor's murum for bedding in 15 cm to 20 cm layers including watering and compaction, etc. complete.

For bedding, only murum supplied by Contractor by paying Royalty to the Concerned Department and approved by Engineer-in-charge. Shall be used. Bedding shall be done before laying of pipes to the desired grade, line and level with necessary watering and compaction etc. complete. This shall be executed when B.C. Soil and hard rock met at the bottom of trench for certain length. The filling in trench around the pipes and 0.30 m on top of pipe line shall be done in B.C. Soil and rock as directed. The item includes lead beyond 0.50 kms. And lift as required. If the approved quality of murum is available within 5 Kms. Lead at any of work, the same shall be used for bedding and refilling as directed by Engineer-in-charge. The payment shall be made as per relevant item No.6 of disposal in Schedule 'B' this can be possible only, if the execution of work is done simultaneously at more site.

Mode of Payment: -

The item shall be measured and paid for one Cubic meter basis.

Item No.7: - Providing supplying in standard length (PE material) HDPE Double wall corrugated pipe for non-pressure underground drainage and sewerage with smooth internal & corrugated external surface confirming to IS 16098:Part - 2 2013 with spigot or plain end with necessary jointing material coupler excluding all statutory duties and taxes such as GST levied by Gol and GoM in all respect, transportation and freight charges, inspection charges, loading and unloading charges conveyance to departmental store/site and stacking the same in in closed shade duly protecting from direct sun ray and rains etc. complete. (Class - SN 8).

The pipes and fittings shall be manufactured out of virgin PE material as per ISO 21138 - 2007 or latest edition. The pipes shall be manufactured out of PE 100 grade compounded resin. The factory testing of pipes shall be carried out as specified in ISO 21138. The resin used shall be tested through third party inspection agencies like Bodycote and according to the specification for the resins. No recycled material shall be used in manufacturing. The stiffness class as mentioned in the BoQ shall be followed. The jointing material shall be SBR or EPDM rubber ring with socket and spigot type of joints. The laying and jointing shall be carried out as per relevant IS - 16098 duly applying the following sections
Transportation –

Annex A -1

Handling A-2

Pipe Storage site A-3

Construction methods A-4

Table 21 min. trench width

Table 22 minimum cover

A 4.1.2.4 Bedding

A 4.4.2.2 Underground services

A 4.1.2.3 Dewatering

A 4.2.2 Jointing

4.2.4 Sewer connections

1. Annex B Structural Design.
2. Annex C Determination of oxidation Induction Time
3. Annex D Methods for visually assessing the effects of heating.
4. Annex E Test method for mechanical strength or flexibility of fabricated fitting
5. Annex F Water tightness of joints.
6. Annex G Test methods for resistance to combined temp. cycling and external loading.

DWC Pipes for use in underground Sewerage System

Technical Specification

Class SN 8 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications.

Scope

This specification covers the requirements for manufacturing, supplying, transportation, handling, stacking, installation, jointing, and testing of Class SN 8 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications herein after called the DWC PE Piping System.

Applicable Codes

The manufacturing, testing at factory, supplying, transportation, handling, stacking, installation, jointing, and testing at sites shall comply with all currently applicable statutes, manuals, regulation, standards & codes. In particular, in addition to all relevant National Standards, following International standards with latest revisions shall be referred. If requirements of these specifications are at variance with any other standards, this particular document shall govern the proceedings.

- I) EN 13476-1
Plastics piping Systems for non-pressure underground drainage and sewerage Structured-wall piping systems of Polyethylene (PE) Part 1: General requirements and performance characteristics.
- II) EN 13476-3

Plastics piping Systems for non-pressure underground drainage and sewerage Structured-wall piping systems of Polyethylene (PE) Part 3 : Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B Other International Codes / Standards (EN/ ISO) which are integral part of above two standards as normative references form a significant portion of this specification document.

Manufacturing

The DWC PE Piping System of stiffness class designation SN 8 shall confirm to the European Union standards as mentioned above and shall be configured as per the indicative Cross-sectional Drawing annexed herewith. Each pipe shall be coupler (on-line or off-line) and spigot type along with rubber sealing ring (as designated under above international specifications)

Transportation

The arrangement of loading the pipes in a telescopic manner is advised, i.e., smaller diameters inserted into the next higher sizes of pipes. While loading the pipes onto the truck, care should be taken that the coupler end should be arranged alternatively in the corresponding layers so as to avoid the damage to the coupling/ socket ends.

Handling

Following Recommendations shall be followed while handling the pipes: Adherence to National Safety requirements Pipes to be smoothly lowered to the ground Pipes should not be dragged against the ground to avoid the damages to the Coupler/pipes. 800mm and larger diameter pipes are carried with Slings at two points spaced approximately at 3 Meters apart For smaller diameters (400mm 800mm) one lift point shall be sufficient & can be handled either manually or mechanically Do not use a loading Boom or Fork Lift directly on or inside pipe.

Pipe Storage at Site

Stockpiling shall be done temporarily on a Flat Clear Area. For avoiding collapse of Stacks, use Wooden Posts or Blocks Stacking shall not be higher than 2.5 Meters While stacking, alternate the socket/coupler ends at each row of stacked pipes. Lowering, Laying & jointing of Pipes The width of a Sewer Trench depends on the soil condition, type of side protection needed and the working space required at the bottom of Trench for smooth installations. Increase in width over required minimum would unduly increase the load on pipe and cost of road restoration. Considering all above factors, the Minimum Trench Width is specified as per Table below: -Indicative Minimum Trench Widths.

Pipe Diameter (mm)	Trench Width (M)
75-170	0.6
250	0.7
400	0.9
600	1.2

800	1.3
1000	1.8

In actual practice the trench width can be as narrow as possible but adequate to allow the workmen to execute the job satisfactorily. The pipe segment between two manholes shall be laid approximately in straight line without any vertical undulations. However, on the strength of its flexibility, the DWC PE Piping system can be laid in very smooth curve if found necessary. The piping system shall rest on the carefully prepared bedding portion of the Backfill Envelope (ref fig. III, Annexure I) and at appropriate jointing locations the trenches shall be excavated deeper to accommodate the bulges of coupler-spigot joints. However, special care shall be ensured as mentioned below: -

Excavation of trenches shall be carried out in accordance with the drawing & specifications and as directed by the field engineer as well. The piping system shall be laid and jointed in true to gradient with the help of sight rails and boning rods as detailed in CPHEEO, MoUD, GoI Manual on Sewerage and sewerage treatment. The levels need be checked with calibrated modern Levelling Instrument. Specific care shall be taken to prevent entry of sand / mud /slush/ any other foreign material etc. into the system during the installation operation. The structural property of the system suggests that a minimum cover of 300 mm adequate even for maximum quantum of superimposed (live) load. In case of wider trenches than required (above table), the permission of the competent authority shall be necessary.

The bedding area is an essential portion of Back fill Envelope and shall be constructed with proper bedding material as computed in accordance with appropriate international code of practice for structural bedding design mentioned in the list of normative references under EN 13476. The bedding shall be laid to specified thickness and gradient with proper manual compaction of the aggregate.

The moulded on-line coupler (or separate coupler integrated to the pipe in case of lower sizes) will have a suitable internal surface for push-fitting the said end over the spigot end of the next pipe. On first valley of the corrugation of said spigot end (destined to receive the pushed coupler) the sealing rubber ring of standard (EN 13476) quality shall be placed so that the coupler end of the pipe smoothly but tightly slides over the sealing ring for making an absolute watertight joint. Similar system is also used for fabricated accessories or moulded fittings required such as Tee, Bends, Elbows, Reducer end caps for the purpose of installation of the system related to drainage/sewerage.

Jointing

For quality connections following steps are to be ensured, failing which the performance aspects are to be severely compromised: -

The non-coupler (socket) end needs to be thoroughly cleared and shall be free from any foreign material Clean and lubricate the coupler end of the pipe, if required Lubricate the exposed Gasket in the same manner, if required. Keep the non-coupler end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised. Push the coupler into non-coupler and align properly. Always push coupler end into non-coupler end. For smaller diameter pipes simple manual insertion shall be sufficient. It should be ensured that the coupler end to ensure installation and tight joining seal. Therefore prior to insertion always place 'homing mark' on appropriate corrugation of non-coupler end. Construction of backfill envelope and final backfilling of the trenches DWC PE Piping System with

well compacted Backfill Envelope along with the bottom and sides of trench (native soil) work together to support soil overburden and superimposed (traffic) loads. The carefully constructed Backfill Envelope has three distinct but non-isolated stages. The construction needs to be done stage by stage as per the sequence stated below:

- Bedding portion
- Up to Haunch level
- Remaining portion

The material for backfill envelope shall be in accordance with the structural design of flexible buried conduit as per relevant international codes mentioned in the list of Standards as normative references of EN 13476 /1 & 3. It can be the same material that were removed in the course of excavation or it can be fine sand/course sand/gravel / murum /other form of course / fine aggregates depending on the effected Design Load [Overburden + Superimposed (Live) load]. However, in no circumstances, the flexible pipe should not be embedded in cement concrete (un- reinforced or reinforced) which invariably induces undesired rigidity in the system. The remaining portion of backfilling which do not contribute to the structural integrity of the system may be the materials that were removed in the course of excavation or any other foreign material as may be required to suit the particular site condition. These materials shall consist of at least clean earth and shall be free from large clod or stone above 75 mm, ashes, refuse and other injurious materials. After completion of lying of pipes, etc, first the Backfill Envelope shall be constructed as per design around the pipe. Voids must be eliminated by knifing under and around pipe or by some other indigenous tools. The compaction, by hand rammers or compactors with necessary watering to a possible maximum level of proctor density shall be ensured. Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open. Precautions shall be taken against floatation (if at all necessary) as per the specified methodology and the minimum required cover for indicative.

Continuity Test /Hydraulic Testing

Continuity of the pipe segments in between two manholes is required to be ensured in the same modality as practiced for non-pressure RCC pipeline. Hydraulic testing of pipes shall be done, if specifically asked for by the client for any specific stretch. The procedure for hydraulic testing shall be similar to that for non-pressure RCC pipes. Hydraulic testing of pipes shall be done, if specifically asked for by the client for any specific stretch. The procedure for hydraulic testing shall be similar to that for non-pressure RCC pipes.

Measurements:

The lengths of pipe shall be measured in the running meters nearest to a cm as laid, lowered and jointed from inside of one manhole to the inside of the other manhole. The length shall be taken along the entire line of the pipes. All fittings such as bends, junction, etc., which shall not be measured separately. Excavation, refilling, shoring and timbering in trenches and cement concreting where ever required shall be measured separately under relevant item of work. Security money for testing should be kept at 15 % of the value of the work. After testing of the complete sewerage system to the satisfaction of the engineer in-charge the same shall be released.

Rate

The rate shall include the cost of material and labour involved in all the operation described above including. the cost of concrete which shall be paid separately.

Item No.8: - Lowering, Laying and Jointing (PE material) HDPE double wall corrugated pipe for non-pressure underground by heating to the ends of pipes with the help of teflon coated electric heater to the required temperature and then pressing the ends together against each other, to form a monolithic & leak proof joint by thermosetting process. The pressing may be required to be done with Jacks/ Hydraulic Jacks/Butt fusion machine etc. complete with all materials labours as directed by Engineer - in - charge. Including

Lowering, Laying and Jointing as per Item No. 7, Sub work No.2.

Mode of Payment: -

The item shall be measured and paid for one running meter length of actual pipeline laid.

Item No.9: - Hydraulic testing of HDPE double wall corrugated pipe for non-pressure underground line to specified pressure including cost of all materials and labour and water for testing for specified length including cutting, placing end cap making arrangement for filling safe water using reciprocating type pumps which should be able to provide specified test pressure gauges and other necessary equipments, labour, operation charges, etc. required for testing. The rate under this item shall also include cost of retesting, if necessary and reinstating to original position.

Hydraulic testing as per Item No. 7, Sub work No.2.

Mode of Payment: -

The item shall be measured and paid for one Km length of actual pipeline laid.

Item No.10: - Providing ISI standard R.C.C. pipes in standard lengths of following class and diameter suitable for either collar joints or rubber ring joints, excluding all statutory duties and taxes such as GST levied by Gol and GoM in all respect, inspection charges, transport to departmental stores/site, unloading and stacking etc. complete as per IS-458/1988. **Class NP – III.**

Note: One collar should be supplied with each full length plain ended RCC pipe, cost including in rates below. One rubber ring should be supplied with each full length of socketed pipe, cost included in rates below.

The relevant item shall comply as per Schedule 'B'

Contractor shall provide R.C.C. S/S Pipes of required diameter and class in standard length as per schedule conforming to latest version of I.S. 458/1956 and the materials required for manufacturing of pipes such as cement shall confirm to I.S. 269 of latest version, sand or fine aggregate and coarse aggregate shall confirm to I.S. 383 of latest version reinforcement shall confirm to I.S. 432, 1786, 1566, 1139, and 226 of latest version R.C.C. work shall confirm to I.S. 456 – 2000, and rubber rings shall be confirm to latest version I.S. The contractor shall supply all the latest I.S. codes related to this item to the Department at his cost.

The pipes supplied by the contractor shall be transported from factory & stacked along the alignments of the line in such a way that no hindrance is created to the traffic / pedestrians. Cracked / damaged pipes shall be rejected outright. Damaged pipe shall not be allowed to be transported at work site. If it happens contractor shall be penalized for such activities in terms of fine as decided by the Engineer-In-Charge. Contractor should take prior permission from Engineer - in - charge before placing the order for RCC pipes. The work is to be carried out zone by zone and in no case pipes required for other zones than the one in which work is going on shall be ordered or brought to site. The work in one zone shall be completed including house connections, commissioned and then only the work for other shall be taken in hand.

After supply of R.C.C. Pipes and rubber rings at the site of work by the contractor, the same material shall be issued to the contractor on "Unstamped Receipt." Record of consumptions and balance shall be maintained and shall be kept in the custody of Department. One rubber ring shall be supplied with each full-length socketed pipe at the site of work and the contractor at his own cost shall submit certificate of testing for the same. The contractor at his own cost shall keep the material at site with chowkidar. The site Engineer can check the balance material any time at site store of the contractor, if any shortage is found, the cost of Short materials with penal rate shall be recovered through R.A. Bill of contractor in single installment without any excuse after the pipes are supplied by the contractor, the responsibility of security and safety shall still rest with the contractor till the pipes are laid, jointed and tested commissioned and the work completed and taken over by the ..MC.

The pipe shall be laid to line, levels and slopes as indicated on the drawings or as directed by the Engineer, Sight rails or leveling instruments in sufficient numbers shall be provided for this purpose by the contractor.

The pipe shall be laid to line, levels and slopes as indicated on the drawings or as directed by the Engineer. Sight rails or leveling instruments of sufficient numbers shall be provided for this purpose by the contractor.

The handling laying of the concrete pipes shall confirm to IS – 783– 1959 (relevant para) The joints shall be done as per paragraph 10.2.3.1 of I.S. 783 – 1959. Any pipe damaged during laying shall be replaced by the contractor at his cost proper alignments tools and facilities shall be provided by the contractor for lowering the pipes, fittings in to trenches to prevent damage. Dumping shall not be permitted. Chain pulley block may be used for pipes above 300 mm. diameter.

All joints shall be done leak proof by providing spun yarn in C.M. 1:1 With hardcrete. The leaking Joint found shall be made water tight at the cost of contractor.

No materials shall be supplied by OMC for manufacturing of R.C.C. pipes and any other allied works.

The pipe shall be inspected, as per relevant latest I.S.S. by Third Party Inspection (TPI) agency approved by the ULB and enlisted with MJP and certificate to that extent shall be produced by the contractor. The charges of TPI are deemed to have been included in the rates. The payment of RCC Pipes shall not be made till receipt of TPI certificate. The seal of TPI agency shall be embossed inside portion of each pipe after inspection including the details such as date of manufacturing, batch no. class and diameter of pipe and name of ULB.

Sight rails and boning staves: -

In laying the pipe sewers, the center for each manhole must be marked by a peg, or otherwise, as may be determined by the Engineer. The contractors are then to dig holes for and set up two posts (about 100 mm x 100 mm x 1800 mm) at each manhole at nearly equal distance from the peg and a sufficient distance there from to be well clear of all intended excavation, so arranged that a sight rail when fixed level against the post will cross the center of manhole. The posts must also be so set up that the longitudinal direction of the rail may be as clear as possible of the direction of any of the lines of pipes or drains converging to the manhole. If walls of building afford suitable means of fixing the sight-rail, the post may, however be dispensed with. The sight rails must not in any case be more than 30 M. apart. Intermediate rails therefore are put up if necessary.

Construction of boning staves: -

Boning staves shall be prepared by the contractors about 75 mm x 50 mm made of a square section of various length, each length being of a certain fraction of meter and with a fixed tee – head and a fixed intermediate cross piece, each about 300 mm. long. The top edge of the cross piece must be fixed at distance below the top edge of this tee-head, equal to as the case may be, the outside diameter of the pipe or thickness of the concrete bed to be laid. The boning staff must be marked on both sides to indicate its full length. According to the circumstances of each case, a suitable length of boning staff will be determined upon, and the reduced level of the bed of the pipe or bottom of concrete of drain at each added to the selected boning staff will be marked by a horizontal line on both posts, or on walls or fences to which the sight-rail is to be fixed.

Sites Rails: -

- a) The sight-rails (about 25 cm wide and 40 mm thick) is to be screwed with the top edge against the level marks. The centerline of the pipe sewer or the drain will be marked on the rail and this mark will denote the meeting point of the centerlines of any converging drains or pipe sewers. A line drawn from the top edge of one rail to the top edge of the next rail will be vertically parallel with the bed of the sewer or drain and the depth of the bed of the sewer or drain at any intermediate point may be easily determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail.
- b) The posts and rails are to be perfectly square and smooth on all sides and edges. The rails are to be painted with white oil paint on both sides, and the tee heads and cross piece of the boning staves are to be painted with black oil paint.
- c) If the pipes of drains converging to a manhole coming at various levels, there must be rail fixed for every different level when a rail comes withing 0.60 M. of the surface of the ground, a higher sight – rail must be fixed for use with the rail over the next point.
- d) The posts and rails must in no case be removed until the trenches is excavated, the drains are constructed or the pipes are laid and permission given to proceed with the filling in.

Laying of RCC Pipes: -

- a) The pipes are to be laid with socket facing up the gradients beginning at the lower end. No pipe to be laid until the trench has been excavated its required depth for distance of 20 m. in front of the pipe to be laid (This distance may vary as be directed by the Engineer In Charge)
- b) All the pipes are to be laid perfectly, both in line and gradient. The pipes in a trench shall be laid and fitted previous to the jointing being commenced.
- c) Properly fitted temporary wooden stoppers shall be provided and constantly used to close the ends of all in completed pipelines. The stoppers are only to be removed when pipes are being laid and jointed.

Jointing R.C.C. Pipes: -

- a) Each concrete pipe with the rubber rings accurately positioned on the spigot shall be pushed well into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a wet or similar appliance.
- b) Concrete pipes of the spigot and socket type with roll on rubber rings shall be used, and the manufacturer's instructions shall be deemed to form a part of this specification.
- c) Rubber rings shall be lubricated before making the joint and the lubricant shall only be soft soap water or an approved lubricant supplied by the manufacture.
- d) In case of R.C.C. pipe entering or leaving a manhole a flexible joint may be provided at least within 0.60 m. from the outer end of the manhole.
- e) A drop in water level of not more than 50 mm in one hour shall be permitted, in case of hydraulic test of manhole.

All works to be water tight: -

- a) The drains, manholes and all joints of pipes must be made thoroughly sound and water tight and if any joint which is proved to be leakage at any time during the progress of works or during the contractor's subsequent period of maintenance shall be immediately made sound by the contractors at their own expenses. The contractors shall at their own cost prove all works to be water tight for filling it with water to such a height as desire by the Engineer-In-Charge. Any additional precautionary measures or appliances that may be found necessary to ensure the water tight joints of pipes shall be adopted by the contractor without extra charges, the responsibility of making them complete watertight rest with the contractor. Hardcrete shall only be used for preparing mortar for jointing of RCC Pipes.
- b) Immediately after the test with the double disc or cylinder has been completed and any defect hereby disclosed have to be made good, the contractor shall prove the joints of the stretch of the under-ground pipe whether of stoneware, Cast iron or R.C.C. Pipes, to be water tight by the filling in pipes with water before filling in the trenches to the level of 1.5 M. above top of the highest pipe in the stretch and heading the water up for the period of one hour of such further time as the Engineer may direct. The apparatus used for the purpose of testing shall be approved by the Engineer. The contractor, if Required by the Engineer, shall pump the excavation dry and keep it so during the period of testing. No test applied at part of a stretch when complete. The loss of water over a period of 30 minutes should be measured adding water from a measuring vessel at

regular 10 minutes interval, and noting the quantity required to maintain the original water level. (For purpose of this test, the average quantity added should not exceed 1 liter / hour / 100 linear meters/ 10 of nominal internal diameter.)

Any leakages including excessive sweating which cause a drop in the test water level will be visible and the defective part of the work should be removed and made good. The testing of laid pipeline shall be given as per specification CPHEEO manual for sewer work.

Inspection of the joints: -

After the joints of any pipes in underground work have thoroughly set the Engineer (or any person whom he may appoint) may inspect the joints and if he has any doubt at their soundness contractor shall arrange to cut, open and clean away the cement as the case may be of any joint, that he may select and to make good the same at their expense provided that unless defect to be found, they shall not be required to open more than one joint in 20 M. of pipes though if the defect be found the Engineer may direct them to open as many joints as he may seem necessary.

Cleaning of the pipes: -

- a) As soon as stretch of R.C.C. pipes has been laid complete from manhole, the contractor shall run through the pipes both back words and forwards a double disc or solid or closed cylinder 75 mm or less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt or any foreign material etc.
- b) If, as a result of the removal of the obstruction, the Engineer considers that damages may have been caused to the pipe shall be entitled to order the length to be retest at the expense of the contractor. If such retest proves unsatisfactory, the contractor shall amend the work and carry out such further tests as are required by the Engineer, at his own expenses.
- c) It shall also be ascertained by the contractor that each stretch from manhole to manhole is absolute clear and without any obstruction visual examination of the interior of the pipe line suitably enlightened by the projected sunlight or other means.

Fracture of Pipes: -

- a) In the events of pipes being fractured at the time of laying, refilling due to dumping of the material for refilling have been improperly selected or any other causes, the contractor in every instance will be held responsible and will be called up to replace the defective pipes at his own cost, if such defect appears before the expiration of the period of maintenance.
- b) Any pipe or length of pipe found to be defective shall be immediately removed and replaced at the contractor's expense, and leaking joints shall be remade, the inspections tests shall then be repeated as often as necessary, until the whole line under inspection or test is accepted by the Engineer.

All Works to be cleared clean and perfect: -

- a) The contractor, shall after completion or whenever required by the Engineer, prove all pipes and fittings to be clear, clean and perfect, and for this purpose shall, at their own expense and in the presence of the Engineer, or his appointee provide suitable instruments and appliances and pass them through the pipes and shall if required, through in water and show that it passed freely through every portion of the work. Brick mortar and rubbish shall not be allowed to fall into the manholes or sewer lines while fixing or if allowed shall be removed by the contractor at their own expenses.

Mode of Payment

supply of Pipes

The pipes RCC required for completion of Sewerage zone shall only be brought after approval from Engineer in Charge. Unless the zone is commissioned and completed, the procurement of pipes on other zone shall not be taken up. 50 % payment will be made against supply of S/S R.C.C. pipes with rubber rings at site along with inspection certificates from TPI agency. Remaining 50% payment will be made only lowering, laying, jointing, satisfactory water tightness testing of the laid pipe line, property connections, and commissioning of the complete zone is completed. The item shall be measured and paid for one running meter length of actual pipeline laid.

Laying of Pipes

50 % payment shall be made after lowering, laying & jointing R.C.C. pipes and 50% payment shall be released after satisfactory water tightness test of the laid pipeline, property connections, and commissioning of the complete zone is completed. The item shall be measured and paid for one running meter length of actual pipeline laid.

Mode of Measurement: -

The lengths of pipe shall be measured in the running meters nearest to a cm as laid, lowered and jointed from inside of one manhole to the inside of the other manhole. The length shall be taken along the entire line of the pipes. All fittings such as bends, junction, etc., which shall not be measured separately. Excavation, refilling, shoring and timbering in trenches and cement concreting where ever required shall be measured separately under relevant item of work. Security money for testing should be kept at 15 % of the value of the work. After testing of the complete sewerage system to the satisfaction of the engineer in-charge the same shall be released.

Item No.11: - Lowering, laying and jointing in proper grade and alignment R.C.C. pipes with collar joints in C.M.1:1 proportion or socketed R.C.C. pipes with rubber joints (excluding cost of rubber ring or R.C.C. collar,) including cost of conveyance from C.M.1:1 proportion or socketed R.C.C. pipes with rubber joints (excluding cost of rubber ring or R.C.C. collar,) including cost of conveyance from stores to site of work, cost of jointing material, labour, etc. complete as labour, etc. complete as directed by Engineer-in-charge (For all class directed by Engineer-in-charge (For all class of pipes.) as per IS-783-1985.of pipes.) as per IS-783-1985.

Lowering, Laying and Jointing as per Item No. 10, Sub work No.2.

Mode of Payment: -

The item shall be measured and paid for one running meter length of actual pipeline laid.

Item No.12: - Hydraulic testing of RCC pipe line to specified pressure including cost of all materials and labour and water for testing for specified length including cutting, placing end cap making arrangement for filling safe water using reciprocating type pumps which should be able to provide specified test pressure gauges and other necessary equipments, labour, operation charges, etc. required for testing. The rate under this item shall also include cost of retesting, if necessary and reinstating to original position.

Hydraulic testing as per Item No. 10, Sub work No.2.

Mode of Payment: -

The item shall be measured and paid for one Km length of actual pipeline laid.

Item No.13: - Providing ISI standard R.C.C. pipes in standard lengths of following class and diameter suitable for either collar joints or rubber ring joints, excluding all statutory duties and taxes such as GST levied by Gol and GoM in all respect, inspection charges, transport to departmental stores/site, unloading and stacking etc. complete as per IS-458/1988. **Class NP – IV**

Note: One collar should be supplied with each full length plain ended RCC pipe, cost including in rates below. One rubber ring should be supplied with each full length of socketed pipe, cost included in rates below.

Specifications same as per Item No. 10, Sub work No.2.

Item No.14: - Lowering, laying and jointing in proper grade and alignment R.C.C. pipes with collar joints in C.M.1:1 proportion or socketed R.C.C. pipes with rubber joints (excluding cost of rubber ring or R.C.C. collar,) including cost of conveyance from C.M.1:1 proportion or socketed R.C.C. pipes with rubber joints (excluding cost of rubber ring or R.C.C. collar,) including cost of conveyance from stores to site of work, cost of jointing material, labour, etc. complete as labour, etc. complete as directed by Engineer-in-charge (For all class directed by Engineer-in-charge (For all class of pipes.) as per IS-783-1985. **Class NP – IV**

Specifications same as per Item No. 11, Sub work No.2.

Item No.15: - Hydraulic testing of RCC pipe line to specified pressure including cost of all materials and labour and water for testing for specified length including cutting, placing end cap making arrangement for filling safe water using reciprocating type pumps which should be able to provide specified test pressure gauges and other necessary equipments, labour, operation charges, etc. required for testing. The rate under this item shall also include cost of retesting, if necessary and reinstating to original position.

Specifications same as per Item No. 12, Sub work No.2.

Item No.16: - Providing and constructing on sewer B.B. masonry circular manhole chamber with concentric cone 1.2m dia. at bottom and 0.5 dia. at top up to depth of 2m, 1.5m dia. at bottom and 0.5m at top up to depth 9.0m, with 20cm thick brick work, up to depth of 2.0m from top of MH and 35cm thick brickwork for next depth up to 5m. Depth of chamber and for depth up to 9m, 23cm thick brick work up to depth 2m from the top of manhole chamber and 35 cm thick brickwork for a depth up to 5 m and 45cm thick brick work for remaining depth up to 9m in C.M. 1:4 proportion with 20mm thick smooth plaster on both sides in C.M. 1:2 proportion including additional excavation, foundation concrete 250mm thick and haunches and channels in C.C. 1:2:4 proportion, finishing channels in smooth rendering, providing and fixing C.I. Dapuri types steps, each weighing 5.5kg, 1:2:4 coping and providing and fixing approved make and quality S.F.R.C. frame and cover of 56cm dia. (20 tonnes capacity), etc. complete as directed by Engineer-In charge.

The item includes excavation in all types of strata for all lifts, P.C.C. for foundation in M-150 grade of various thickness B.B. Masonry in 1:3 proportion of various thickness ranging from 23 cm to 46 cm as per type design, R.C.C. slab in M-150 grade including cost of reinforcement, 20 mm thick cement plaster in two coats in C.M. 1:3 proportion from inside and outside, top C.C. coping in – 150 grade (1:2:4) providing and fixing C.I. Dapuri steps or P.V.C. coated of approved make steps at 0.30 m c/c, refilling, disposal of surplus excavated stuff up to 5 Kms. Lead including curing, testing etc. complete as directed. Following specifications contained in standard specifications book (Red Book) shall apply.

i)	Excavation in all type of strata.	Bd-A-1 to A-6 on Page No. 259
ii)	P.C.C. 1:2:4 (M-50 grade)	Bd-E-1 Page No. 287
iii)	R.C.C. Work such as slab etc.	Bd-G-1 Page No. 313
iv)	R.C.C. work such as slab etc.	Bd-F-3,22,23 & 24 on Page No. 282,292 & 293.
v)	Reinforcement	Bd-F-17 Page No. 306
vi)	20mm thick cement plaster in C.M. 1:3	Bd-L-5 Page No. 368
vii)	Refilling.	Bd-A-10 Page No. 263

Slab shall be provided at intermediate stage as per type drawing. The intermediate slab is to be cast in situ. The reinforcement in this slab is expected to be around 1% of concrete volume and design of reinforcement shall be given by contractor and got approved by Executive Engineer. The frame and cover for the top slab (Manhole) should be of Steel Fibber Reinforced Concrete (S.F.R.C.) of Bharat, Pratibha and K.K. Technology. The brochure of S.F.R.C. frame and cover shall be submitted by the contractor and got approved from Engineer-in-charge. The frame and cover shall be branded with the letter 'O.M.C.'

Kiln burnt bricks for manhole of approved quality only be used and shall be got approved from Engineer-in-charge. The samples of bricks shall be tested as per I.S. for various test in Government Engineering College. The testing certificate shall be produced by the contractor at his own cost. No. extra payment shall be made to the contractor on account of

testing including transportation of samples etc. All the materials such as cement, bricks, aggregate, frame and cover, steps etc. shall be brought at the site of work at the cost of contractor.

The detailed specification for materials such as cement, fine and coarse aggregate and others shall be referred as per specification of I. No. (3) as mentioned in this tender.

The manhole than they have been raised above the highest subsoil water level expected in the monsoon shall similarly tested for water tight as far the pipe lines. The procedure for testing shall be as follows.

The mouths of all pipes entering the manhole shall be suitably plugged with bricks, wooden or any other types of plug. The manhole under test shall then be filled with water up to the general subsoil water level and observe for and period of one hour. If the level dose not drop by more than 50 mm in one hour, it shall be assumed that the manholes is watertight.

During the period of test, the outside trench shall be kept free from any accumulation of subsoil water. In case of a drop of more than 50 mm in water level, the contractor shall note the places from where the leakage's taking places and take step to stop the leakages satisfactory.

All manholes shall be tested for water tightness in all conditions by adopting the procedure as mentioned above. The manholes shall be cleared of all debris etc. and shall be thoroughly cleaned. No utility services such as cable, pipe line etc. shall be allowed to remain inside the manhole. Care should be taken to shift the same outside the manhole with the cost or contractor.

The type design/drawing or various types, sizes and depth of manhole is attached herewith. In case of any discrepancy between the drawing and specification the decision of Engineer-in-charge shall be final and binding on the contractor. The rate given in Schedule 'B' is for particular depth. The Depth of chamber is the height of masonry as shown in the type design. For the purpose of measurement, the top of bottom P.C.C. to the top of slab/cover as shown in the drawing shall be considered.

During course of execution any manhole chamber/cover damaged due to whatever may be the reason shall be made good by the contractor at his own cost. This shall be applicable till scheme is commissioned. After execution if it is found that manhole chamber level is not matching with the road level that shall be matched by the contractor at his own cost.

Mode of payment: -

90% payment after completion of construction work and 10% after hydraulic testing of manhole.

Item No.17: - Providing and constructing on sewer RCC. circular manhole chamber with concentric cone 1.2m to 1.5 dia. at bottom and 0.5 dia. at top up to depth of 2m to 7.5 m, with 20cm to 25 Cm thick wall (As per Design) , with 20mm thick smooth plaster on both sides in C.M. 1:2 proportion including additional excavation, foundation concrete 250mm thick and haunches and channels in C.C. 1:2:4 proportion, finishing channels in smooth rendering, providing and fixing C.I. Dapauri types steps, each weighing 5.5kg, 1:2:4 coping and providing and fixing approved make and quality S.F.R.C. frame and cover of 56cm dia. (20 tonnes capacity), etc. complete as directed by Engineer-In charge.

The item includes excavation in all types of strata for all lifts, P.C.C. for foundation in M-150 grade of various thickness RCC Work for Walling in M25 Grade of designed thickness ranging from min. 150 mm to as per type design, R.C.C. slab in M-150 grade including cost of reinforcement, providing and fixing C.I. Dapuri steps or P.V.C. coated of approved make steps at 0.30 m c/c, refilling, disposal of surplus excavated stuff up to 5 Kms. Lead including curing, testing etc. complete as directed. Following specifications contained in standard specifications book (Red Book) shall apply.

i)	Excavation in all type of strata.	Bd-A-1 to A-6 on Page No. 259
ii)	P.C.C. 1:2:4 (M-50 grade)	Bd-E-1 Page No. 287
iii)	R.C.C. Work such as slab etc.	Bd-G-1 Page No. 313
iv)	R.C.C. work such as slab etc.	Bd-F-3,22,23 & 24 on Page No. 282,292 & 293.
v)	Reinforcement	Bd-F-17 Page No. 306
vi)	20mm thick cement plaster in C.M. 1:3	Bd-L-5 Page No. 368
vii)	Refilling.	Bd-A-10 Page No. 263

Slab shall be provided at intermediate stage as per type drawing. The intermediate slab is to be cast in situ. The reinforcement in this slab is expected to be around 1% of concrete volume and design of reinforcement shall be given by contractor and got approved by Executive Engineer. The frame and cover for the top slab (Manhole) should be of Steel Fibber Reinforced Concrete (S.F.R.C.) of Bharat, Pratibha and K.K. Technology. The brochure of S.F.R.C. frame and cover shall be submitted by the contractor and got approved from Engineer-in-charge. The frame and cover shall be branded with the letter 'O.M.C.'

No extra payment shall be made to the contractor on account of testing including transportation of samples etc. All the materials such as cement, aggregate, frame and cover, steps etc. shall be brought at the site of work at the cost of contractor.

The detailed specification for materials such as cement, fine and coarse aggregate and others shall be referred as per specification of I. No. () as mentioned in this tender.

The manhole than they have been raised above the highest subsoil water level expected in the monsoon shall similarly tested for water tight as far the pipe lines. The procedure for testing shall be as follows.

The mouths of all pipes entering the manhole shall be suitably plugged with bricks, wooden or any other types of plug. The manhole under test shall then be filled with water up to the general subsoil water level and observe for and period of one hour. If the level dose not drop by more than 50 mm in one hour, it shall be assumed that the manholes is watertight.

During the period of test, the outside trench shall be kept free from any accumulation of subsoil water. In case of a drop of more than 50 mm in water level, the contractor shall note the places from where the leakage's taking places and take step to stop the leakages satisfactory.

All manholes shall be tested for water tightness in all conditions by adopting the procedure as mentioned above. The manholes shall be cleared of all debris etc. and shall be thoroughly cleaned. No utility services such as cable, pipe line

etc. shall be allowed to remain inside the manhole. Care should be taken to shift the same outside the manhole with the cost of contractor.

Design for the manhole for various depth and sizes shall be carried out by the contractor at its own cost. In case of any discrepancy between the drawing and specification the decision of Engineer-in-charge shall be final and binding on the contractor. The rate given in Schedule 'B' is for particular depth. The Depth of chamber is the height of RCC Vertical walling as shown in the type design. For the purpose of measurement, the top of bottom RCC Slab/Raft to the top of slab/cover as shown in the drawing shall be considered.

During course of execution any manhole chamber/cover damaged due to whatever may be the reason shall be made good by the contractor at his own cost. This shall be applicable till scheme is commissioned. After execution if it is found that manhole chamber level is not matching with the road level that shall be matched by the contractor at his own cost.

Mode of payment: -

90% payment after completion of construction work and 10% after hydraulic testing of manhole.

Item No.18: - Refilling the trenches with available excavated stuff with soft material, first over pipeline and then hard material in 15cm layers with all leads and lifts, including consolidation, surcharging etc. complete.

The item shall be done as per standard specification No. Bd-A-10, Page No.263

After lowering, laying, jointing and welding of pipe line, site guniting and concreting work, refilling of trenches with available excavated stuff shall be done.

For bedding only approved quality of excavated materials from trenches shall be used. Bedding shall be done before laying of pipe line to the desired grade as directed by Engineer-in-charge.

For refilling purpose, approved excavated stuff shall only be used. The refilling shall be done in layers of 15 to 20 cms. Each layer should be watered and compacted properly before the upper layer is laid till the required level is reached. First 2 layers of 15 to 20 cms. shall be free from stones or chips or any harmful material, to protect the pipe from damage. Only soil or soft murum shall be used for filling. Originally filling shall be done 30 to 40 cms above natural ground or road level. Sinking below the road or ground level, if noticed till the completion of work, the contractor shall have to make it level at his cost.

Item No.19: - Removing and transporting the exavated surplus material of all categories and disposing of the same as directed, including loading, convyeing, spreading or stacking beyond the initial lead of 5 Km as directed etc. complete

1) After refilling of trenches, surplus excavated stuff remaining at the site of work have to be disposal off at suitable places within five Km. distance, as directed by Engineer-in-charge.

2) Surplus excavated materials are the property of OMC and therefore contractor is not empowered to sell this excavated material to any other agency.

- 3) This disposal will not be considered for initial 50 M. lead from site of work, so will not be paid for.
- 4) The materials shall be conveyed by means of suitable devices.
- 5) The material conveyed to the place of disposal shall either be stacked or spread as directed by Engineer-in-charge or his representative.
- 6) The route for operation and maintenance, payment of any royalties, compensation to land owners and for damages if any etc. during the process of conveyance etc. shall be the entire responsibility of the contractor.
- 7) This item includes all labours, materials and equipments required for loading, conveyance, unloading, stacking or spreading the material.
- 8) The tender rate shall be for one cubic meter of excavation quantity conveyance to the place of disposal.
- 9) The quantity conveyed and disposed of shall be calculated from the trench excavation after deduction of quantities for bedding, concrete or any other refilled materials and balanced net excavation quantity will be payable under this item.

Item No.20: - Item No.20 Providing, fixing and erecting RCC (M20) Vent shaft with cowl, 125mm x 225mm internal and external dia respectively at top, 300mm and 450mm internal and external dia at bottom and 9.10m over all length, bottom 1.25m below ground level fixed in the pit 900mmx900mmx1500mm with PCC M15, 250mm in bed and 200mm around with top 150mm in cement concrete 1:2:4 (1 cement 2 coarse sand and 4 graded stone aggregate of 20mm nominal size) junction of vent shaft and concrete grouted with cement mortar 1:2 (1 cement and 2 fine sand) including making connection with sewer manhole with 150 mm dia NP4 RCC pipe (IS 458- amended up to date) for 5.0 m length including Murum bedding complete and as per standard design and finished with water proofing cement of approved brand of required shade as per drawings and/or as directed by Engineer. Providing and fixing RCC ventilation shaft, making connection to manhole etc. complete as directed by EIC.

The relevant item shall comply as per Schedule 'B' and as directed by Engineer in Charge.

Item No.21: - Providing and laying in situ, following grades of C.C. of trap/granite/ quartzite /gneiss metal for foundation and bedding including dewatering form work, compacting and curing etc, complete. **1:2:4 (M150)**

This shall comply as per standard specification No. Bd-E-1 on page No.287 or latest edition.

1.1. Materials

1.13.1. Cement: -

All cement for use on the works except otherwise stated shall be the standard ordinary Portland cement manufactured in India and shall conform to the I.S. 269 latest version. It shall be of make and quality approved by the Engineer-in-charge.

The cement shall be stored in weather proof godown specially constructed for the purpose, of such a manner as to prevent deterioration due to moisture or intrusion of foreign matter. The weather proof godown shall have solid impervious floor raised 300 mm above the general ground level so that the cement stored there on shall not come in

direct contact with the sub-soil moisture. The passages and the general construction shall be such that it affords full protection from weather effects. Large stock cement shall not be kept at the works but only sufficient quantities should be kept to maintain continuity of work.

1.13.1.1. Storage of Cement: -

If cement is supplied in bags a suitable weighing scale shall be provided and shall require by the Engineer be used for checking the weight of every bag at the contractor's expense. Bags under weight by more than 2 percent of the nominal weight shall be rejected and removed from the site.

No cement has been stored for more than 90 days ordinarily be allowed to be used on the works. Cement stored for longer period more than 90 days shall be used on work only with the specific written permission of the Engineer-in-charge who shall ascertain its quality after due testing in the laboratory before giving such permission. All expenses in connection with the test shall be borne by the contractors.

For testing the quality of cement, samples shall be taken from every consignment arrived at the site of work at the option of the Engineer. The contractors shall afford every facility to the Engineer for inspection for sampling the cement. The cement godown shall be so arranged by the contractors that each consignment could be stocked separately and, in such manner, so as to allow counting bags in each row with ease. The test result shall, ordinarily be available within a week of sampling and the contractors shall not use any part of the consignment until the results of the tests are received and found satisfactory. However, the use of such cement becomes imperative before the test result are received, the contractors may do so entirely at their own risk and cost and the whole of such work carried out by them is liable for rejection, if the tests results are found unsatisfactory. Any consignment failing to meet the requirements to I.S. 269 shall be rejected and shall be removed from the work site within 48 hours of the intimation from the Engineer. The decision of the Engineer-in-charge in this respect shall be final and binding on the contractors.

The cement in connection with the testing of cement such as transport of samples, testing fees, etc.

shall be borne by the contractors.

The cement used in any type of concrete shall always be measured by weight and one cubic meter shall be taken as per table 30 of A.C.C. Hand Book.

1.13.2. Aggregates: -

All the aggregates shall conform to the latest I.S. 383. The aggregate shall consist of naturally occurring sand and gravel or stone crushed or uncrushed or a combination thereof. They are classified broadly under two categories, viz (i) Sand of fine aggregates and (ii) coarse, aggregates, depending upon their size. The fine aggregates are those which pass through I.S. Sieve No. 480. and the coarse aggregate are those which retained on I.S. sieve 480.

1.13.2.1. Storage of Aggregate: -

- (i) The fine and coarse aggregates shall be stored separately and in such a manner that segregation of the various sized particle shall not occur, the stock shall be formed on a platform of weak concrete, timber or similar approved hard standing and aggregates shall be kept clean and free from foreign substance.

- (ii) Aggregates shall not be unloaded on to roadways or pathways the Engineer may reject any stock pile of part of a stock pile if improper storage has opinion, caused contamination with foreign substances.
- (iii) Storage piles of aggregate shall be arranged with proper drainage and protection from rainfall in order to prevent excessive changes in moisture content taking place during concerning.
- (iv) The aggregates both fine and coarse shall be hard, strong, durable, clean, free from veins and adherent coatings. The use of flaky and elongated pieces of aggregates shall be prohibited.
- (v) The aggregate shall not contain deleterious materials such as iron pyrite, coal, mica, shale or similar laminate material, clay, alkali, soft fragments, sea shells, organic impurities etc. in such quantity as to affect the strength of durability of concrete or the reinforcement embedded in such reinforcement concrete.
- (vi) The maximum quantities of deleterious material that may be permitted shall conform to the following limits by weight.

Sr. No.	Deleterious substance	Fine aggregates percent by weight		Coarse aggregates percent by weight.	
		Uncrushed	Crushed	Uncrushed	Crushed
1)	Local and lignite	1.00	1.00	1.00	1.00
2)	Clay lumps	1.00	1.00	1.00	1.00
3)	Soft fragments	-	-	3.00	-
4)	Material passing through 75 micro sieves.	3.00	3.00	3.00	1.00
5)	Shale	1.00	-	-	-

- (vii) The total of various deleterious materials occurring in any sample shall, no case, exceed 5 percent.
- (viii) If the aggregate supplied is unclean, it shall be washed. If it is not properly graded, it shall be screened by hand or by mechanical means and the various sizes proportioned to get the required grading.
- (ix) Storing of aggregate on dusty, muddy and grassy spots shall be avoided. They shall be stored on the works in such a manner as to prevent intrusion of foreign matter and protected from exposure to dust. They shall be placed in stock piles individual units of suitable sizes and in suitable layers to prevent segregation. They shall not be allowed to run down slopes.

1.13.3. Sand or fine aggregates: -

All fine aggregates shall consist of clean, hard, strong, durable uncoated siliceous gitty material consisting of well graded particles obtained from rock fragment. It shall be free from clay lumps injurious amount of dust, mica shell, soft or flaky particles, shale, alkali, organic matter lead or other deleterious substances.

- (i) The sand shall be taken from sources approved by the Engineer-in-charge. The sand or fine aggregate shall conform to the latest I.S. No. 383
- (ii) If the Engineer-in-charge considers if necessary, it shall be washed and / or screened before use, at the expense of the contractors.
- (iii) The sand shall have a fineness modulus of not less than 2.5 and not more than 3.0 and the grading shall confirm as far as possible to the following analysis.

I.S. Sieve No.	Percentage Passing	
	Natural sand or crushed gravel	Crushed Stone
480	95-100	90-100
240	70-95	60-90
120	45-85	40-80
60	25-60	20-50
30	5-30	5-30
15	0-10	0-15

- (iv) The specific gravity of sand shall not be less than 2.6.
- (v) In no case shall fine aggregate be accepted, containing more than 2 % by dry weight not more than 3.5% by dry volume, not more than 5% by dry volume of clay, loam, or silt. If any sample of fine aggregate shown more than 5% of clay, loam, silt in one hour's settlement after shaking in excess of water, the lot represented by the sample shall be rejected.
- (vi) The following two field tests are recommended for ascertaining the percentage of clay lumps and impervious organic material and the contractors shall carry out the same if the Engineer-in-charge deems necessary.

1.13.3.1. Test for determining silt in sand: -

Fill a calibrated tumbler with sand to half its volume and water there to until the tumbler is three quarters full. Shake up the mixture vigorously and allow it to settle for about an hour. The volume of silt visible on top the sand shall be measure. If the volumes of the silt standing over the sand exceed 5% of total volume of sand. The same shall be rejected.

1.13.3.2. Calorimetric test for impurities: -

The sample of sand shall be mixed with equal volume of 3% solution (about one ounce, in a quarter of water) of caustic soda / sodium hydroxide taken in a plain glass and the mixture shall be allowed to stand for 24 hours. The liquid standing above the sand shall not be darker than lights straw (pale yellow) color. If the color marked yellow or brown, the test would indicate presence of organic material in excessive amount.

In case suitable sand is not available in adequate quantities within a reasonable and economical limit, the contractor may be allowed to use the crushed or pulverized stone or gravel either alone or mixed within natural sand in parts. The stone or gravel shall be clean sharp and free from dust etc. and shall conform to the latest. I.S. 383.

The percentage of crushed stone to be mixed with sad shall be such as to obtain in fineness modules of blended sand within the units specified above and / or as approved by Engineer after laboratory test.

1.13.4. Coarse Aggregates: -

All coarse aggregates use in concrete work shall consist of crushed rock gravel or other approved inert material.

- (i) Broken or crushed rock from sound blue basalt or black trap free from zealot or other common impurities shall be used in the concrete as coarse aggregate. The particles of aggregate shall be clean, hard, tough durable, free from deleterious substance and shall contain no soft, flat or elongated pieces. The coarse aggregate shall have specific gravity not less than 2.6 and the water absorption measured after being immersed for 24 hours in water shall not be more than 6% by weight. The maximum percentage of deleterious materials in the coarse aggregate shall not exceed 5 % by weight in the aggregate when tested in conformity with I.S. No.383.

- (ii) The nominal size of the coarse aggregate for reinforced concrete work shall be 20 mm larger coarse aggregate up to 40 mm size may be used if approved by the Engineer-in-charge, in plain concrete work. The maximum size of coarse aggregate shall be as large as possible within the limits specified but in no case shall be greater than one quarter than one quarter of the maximum thickness of the member, provided that the concrete can be placed in from work without difficulty so as to surround all reinforcement thoroughly and to fill the corners of the form work. The minimum size of coarse aggregate shall be, as mentioned earlier, such as to retain most of the material (90% - 95%) on L.S. Sieve No. 480.
- (iii) The aggregate shall be screened and, if necessary, blended to give the required grading when tested in the laboratory at contractors cost by means of standard mesh sieve, the grading shall fall within the following limits.

Sieve Size	Percentage retains by weight	
	Plain C.C.	R.C.C.
40 mm	-	-
25 mm	10 to 15	-
20 mm	35 to 40	15 to 0
10 mm	75 to 80	100 to 80
No. 480	98 to 100	100 to 95

The percentage given above are for guidance and the Engineer-in-charge reserves the right to modify the same to any other lower or higher value if considered necessary by him, in consonance with the requirements of the work.

- (iv) In the event of undesirable segregation occurring in coarse aggregates, the contractor shall separate the coarse aggregates in two or more suitable fraction as directed by the Engineer-in-charge, who shall set up the required limit of each such fraction. The grading so specified shall be such as to give a dense, water tight concretes of specified proportion and strength and required consistency.
- (v) The Engineer-in-charge shall have the right and authority to carry out routine control tests and analysis of the broken rock at any stage of the work processing and / or concerning operation and the contractors shall give all necessary facilities in respect of such testing. The sampling and testing shall be carried out as per standard I.S. practice entirely at the cost of the contractor.

1.13.5. Water: -

The water uses for the preparation of concrete, for washing sand etc. and for curing shall be clean and free from objectionable quantities of silt, organic material, acid, alkali, salts, oil and other deleterious impurities and it shall be obtained from the sources approved by the Engineer-in-charge. Potable water shall generally be found fit for preparation of concrete. The quantity of water to be added shall generally be properly measured and controlled.

1.13.5.1. Water Cement Ratio: -

Suitable water cement ratios for the different mixes and used shall be determined in consultation with the Engineer-in-charge and they shall generally not be exceeding 0.5 (i.e., 50% by weight), the exact values being fixed after taking into account all relevant factors such as strength required, weather condition, water absorbed by material, work ability and slump required consistent with the work requirements, method of compaction etc. The concrete mix shall be designed with the materials which will be used hence forth for the preparation of concrete. The same task shall be repeated if there is change in the quarries for the fine and the coarse aggregate.

1.13.6. Concrete: -

All cement concrete, whether used in R.C.C. work or plain concrete work shall be M-150, M-200 and M-250, as per latest LS. Code.

1.13.7. Gauge Boxes

Gauge boxes approved type shall be used for measuring sand and coarse aggregate in required proportion whenever concrete is allowed to be prepared by mixing the aggregate on volumetric basis. Such boxes shall be of seasoned timber or steel and shall be of such size and shape and shall be used in a manner as to enable the proportion of the material to be checked readily. The cement used in concrete is however shall not be used by measuring it in gauge boxes, but it shall be measured by weight, whatever may be the type of concrete.

1.1. Manufacture and Placement of concrete: -

1.14.1. Batching: -

Whether controlled or ordinary concrete is to be mixed, the quantity of cement shall be determined by weight. If the mixers weight per bag is to be used, the same shall be verified by weighing a reasonable number of bags.

Whenever direct use of bagged cement is allowed, one bag of cement shall be considered to contain

50 kg of net weight of cement. This shall, however, be verified at site by weighing for which the contractor shall provide an accurate weighing apparatus on work sites.

Having once decided the mix, the Engineer-in-charge may permit further mixing of the aggregate to be done on volumetric basis.

Wherever the concrete is to be laid in trenches, the trench shall clean, watered and compacted before placing. The sub soil water which met shall be removed and the trench shall be kept dry during and after two hours of placing of concrete. For more depth of P.C.C. mechanical vibrator shall be used for compaction by the contractor.

The damages to concrete during laying of pipe line shall be rectified free of cost. The rate for the concrete includes all labour, material centering shuttering securing etc. all leads and lifts. Mixing of concrete shall be done with concrete mixer. For providing Electric wiring duct, tubes of the required diameter and length shall be provided through walls beams and floors, slabs as and when directed without any extra cost.

- a) The contractor will make his own arrangement for receiving all material tools etc. required for the work.
- b) No extra charges for the carriages of water will be allowed.
- c) The rates for all items are inclusive of all charges such as carting, lifting, etc. No extra payment for any lead and lifts will be paid for any item.
- d) The contractor should not be Sublette without written permission of the Engineer-in-Charge.

Cement cubes of size 15 cm x 15 cm x 15 cm are taken during the concreting of important structure like RCC well, water treatment plant, elevated service reservoirs, bridge etc. to check the strength of the concrete and its acceptability it is observed that while taking cubes the requirement specified in the relevant Indian Standard specification are not observed properly and cubes are not cast in the required numbers. Due to this the acceptability of the concrete cannot be decided correctly. Similarly, proper care is also not taken for curing of the cubes the requirements specified in the

ISS in respect of casting of concrete cubes and curing thereof, with acceptability criteria of concrete are reproduced below, which shall be following scrupulously.

1.14.2. FREQUENCY OF SAMPLING (IS: 456:2000 (Clause 15.2)

Number of samples to be taken during concreting based on the quantum of concrete cast shall be as below.

Quantity of concrete in	No. of samples
01 to 05	1
06 to 15	2
16 to 30	3
31 to 50	4
50 and above	4 + 1 for every 50 Cum part thereof.

At least one sample shall be taken from each shift of concrete and three test specimens (cubes of size (15 x 15 x 15 cm) shall be cast from each such sample for testing of the compressive strength additional three cubes will also have to be taken for 7 days test.

The test strength of the sample shall be the average the strength of the three specimens.

1.14.3. ACCEPTANCE CRITERIA (IS: 456:2000 Clause 16)

The concrete cost shall be supposed to be acceptable in the compressive strength (i.e., average strength of the three specimen) of the samples fulfill the following requirements.

- a) Every sample has a test strength not less than characteristic value.

OR

- b) The strength of one or more samples, though less the characteristic value is in each case, not less than the greater of following.

- i) The characteristic strength minus 1.35 times the standard deviation.

and

- ii) 0.80 times the characteristics strength.

- c) And the average strength of all the samples is not less than the characteristic strength plus 165

$$= \left[1.65 - \frac{1.65}{\sqrt{\text{No, of Sample}}} \right] \times \text{times the standard deviation}$$

- d) However, it should be noted that individual variation should not be more than the percent of average.

Standard Deviation Value	
Grade of Concrete	Assumed Standard deviation in Kg/Cm ²
M-100	35.00
M-200	46.00
M-250	53.00
M-300	80.00

1.14.4. CURING OF CONCRETE CUBES (IS: 516:1959, CLAUSE 3.3)

The test specimen (cubes) shall be stored on the site at place free from vibration, under damp matting, sacks or other similar material for 24 hours + ½ hour from the time of adding the water to the other ingredients. The temperature of the place of storage shall be within the range of 22° to 32°C. After the period of 24 hours, stored in clean water at temperature of 24° to 30°C until those are transported to the testing laboratory. Samples shall be sent to the testing laboratory well packed in damp sand, damp sacks or other suitable material as to arrive there in a damp condition, not less than 24 hours before the time of test.

On arrival at the testing laboratory, the specimen shall be stored in water at a temperature of 27° + 2° C until the time of test. Record of the daily minimum and maximum temperature shall be kept, both during the period specimen remain on the site and in the laboratory.

1.14.5. TEST PROCEDURE (IS: 516:1959 CLAUSE 5.5)

Specimen stored in water shall be tested immediately on removal from water and while those are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed. Specimen, when received dry, shall be kept in water for 24 hours before taken for testing. The dimensions of the specimens to the nearest 0.2 mm and also weight shall be noted before testing.

1.14.6. OTHER THINGS

Here, it should be specifically noted that age of concrete cube will be age as on the date of testing i.e. time difference between addition of water to dry ingredient and actual testing.

1.1. MIX DESIGN

The following instructions shall be followed as regards preliminary design of mix and methods of batching of plain cement and reinforced cement concrete. These instructions should be treated as supplementary to the relevant provision in the specifications for the respective items contained in the book of standard specification and will be carried the provisions contained therein, wherever they are contrary to the following instructions.

The preliminary design and batching for various grades of concrete shall be governed by the following guidelines.

No.	Concrete Grade	Guidelines
1	Up to M-150	This should only be ordinarily concrete. No change may be prescribed in the present practice as regards preliminary design of mix and permitting volume batching.
2.	M-200 to M-250	Preliminary mix design must be carried out for these mixes. However, weigh batching shall be insisted for cement, fine aggregate and coarse aggregate.
3.	Above M- 250	Preliminary mix design must be prepared for such mixes weigh batching should be for cement fine aggregate and coarse aggregate.

For the grades of concrete M-200 and above the preliminary mix design shall be carried out from the approved laboratory. The rate quoted by the contractor in the agreement for these items shall be final and binding on him,

irrespective of content of cement required as per preliminary mix design and there shall be no adjustment in the agreement rate for these items on this account.

The charges for preliminary design of concrete mix shall be entirely borne by the contractor.

For grades of concrete M-200 and above where cement is to be used by weightment, the cost of extra cement required to make up the under-weight bags shall be borne by the contractor.

For the items of concrete of grades lower than M-200 and other items in the agreement where cement is not to be used by weightment the cement bags as received from the manufacturer and shall be assumed to contain cement of 50 kg net weight.

This shall be as per specification of P.W.D. (Hand Book) and as directed by Engineer-in-charge. Only trap stone shall be used other than the specification for this item in Standard Specification Book.

(a) Proportions of concrete for types of work.

- i) M-100 – For leveling course and foundation of chairs and thrust blocks etc.
- ii) M-150 PCC with temperature nominal 0.15% reinforcement for footing thrust blocks, anchor blocks, chairs and encasing of pipes etc.
- iii) M-200 PCC for water retaining structure
- iv) M-300 for Construction of Wet well, Pump House & Water Retaining Structure. Such as ESR, WTP, MBR, BPT.
- v) M-250 Pump house and bridges (excluding sub-merged portion)

(b) General specifications of this work shall be as per standard specification of Public Works Department, latest edition, for PCC Bd.-E1 to E-7 and for RCC Bd. F2 to F16.

(c) Whenever concrete is to be laid in trenches, the trench shall be cleaned, and watered before placing. The sub-soil water which is met shall be removed and the trench shall be kept dry during and after 2 hours of placing concrete.

(d) Pedestal pier shall be perpendiculars to center line of pipe.

(e) Proper seat shall be left on top of pedestal pier to construct saddle. Seat shall be strictly done within 24 hours, failing which PMC will not accept it for payment.

(f) RCC saddle shall be constructed as per detailed drawing. The top of saddle where pipe rests shall be provided with wearing plate fixed in CM 1:3 smoothly and CM grouting may be done after pipe is placed and no extra payment will be made for this.

1.1. MODE OF MEASUREMENT AND PAYMENT.

The tender rate shall be for one cubic meter of concrete. The concrete shall be measured for its length, breadth and depth limiting dimensions to those specified in drawing or as per direction of Engineer- in-Charge.

Item No.22: - Dismantling dead pipeline of MS/ RCC/ CI/ PSC and GI/ AC/ PVC/ SW/ HDPE. pipe including cost of necessary excavation and refilling of trenches, breaking the joints, lifting the pipes and stacking to the places as directed by Engineer-in -charge with all leads and lifts including cleaning the surface etc. Complete.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one-meter basis.

Item No.23: - Providing D.I. pipes (push on joints pressure pipes of D. I. of following class and diameters confirming to the I. S. specification inclusive cost of jointing materials (Rubber gasket of EPDM Quality) excluding GST levied by GOI & GOM in all respect including Third party inspection charges of TPI Agency approved by MJP including Transit insurance, Railway Freight, Unloading from railway wagon, Loading into Truck, Transportation to departmental store, unloading, stacking etc. completed as directed by Engineer in charges (IS 8329/2000 for pipes and IS 158/1969 and IS 12820/1989 or latest edition/ revision with amendments for Rubber Gaskets. Class K-7.

1.1. Scope

This specification covers the requirements for manufacturing, supplying, laying, jointing, testing and commissioning of Ductile iron pipeline and fittings including associated civil works required for the same. Reference should also made to the requirements of Part 6 where appropriate.

1.17.1. Standards

The following standards, specifications and codes are part of this specification. In all cases, the latest revision of the codes including all applicable official amendments and revisions shall be referred to. In case discrepancy between this specification and those referred to herein, this specification shall govern.

IS: 8329	Centrifugally Cast (Spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage
IS: 638	Sheet Rubber Jointing and Rubber Insertion Jointing
IS: 1387	General requirements for the supply of metallurgical materials
IS: 1500	Method for Brinell Hardness Test for Metallic Materials.
IS: 9523	Ductile Iron Fittings for Pressure Pipes for Water, Gas and Sewage
IS: 12820	Dimensional Requirements of Rubber Gaskets for Mechanical Joints and Push-on Joints for Use with Cast Iron Pipes and Fittings for Carrying Water, Gas and Sewage.
ISO: 4179	Ductile iron pipes for pressure and non-pressure pipelines — Centrifugal cement mortar lining — General requirements
ISO: 2531	Ductile iron pipes, fittings, accessories and their joints for water applications
IS: 5382	Specification for Rubber, Sealing Rings for Gas Mains, Water Mains and Sewers
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances.
IS: 11906	Recommendations for cement mortar lining for cast iron mild steel and ductile-iron pipes and fittings for transportation of water.
IS: 3764	Excavation Work - Code of Safety
IS: 12288	Code of Practice for Use and Laying of Ductile Iron Pipes
IS: 460	Test Sieves: Part-I Wire Cloth Test Sieves
IS: 8112	Specification for 43 grade ordinary Portland cement
BS: 3416	Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water

BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and Test Methods.

1.1. Manufacturing

1.18.1. General

DI pipes and fittings (Class K7) shall be in accordance with IS 8329 and IS 9523.

Pipes and fittings shall be procured from reputed manufacturers with Engineer's approval. Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing. All tests specified either in this specification or in the relevant Indian Standards specified above shall be performed by the supplier / contractor at his own cost and in presence of Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Engineer. If the test is found unsatisfactory, Engineer may reject any or all pipes and fittings of that lot. The decision of Engineer in this matter shall be final and binding on the contractor and not subject to any arbitration or appeal. The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects. Any defect in pipes and fittings in the opinion of Engineer shall be rejected and shall be replaced by new one. In the case of spigot and socket pipes and fittings the socket shall be without the centering ring. In the case of flanged pipes, the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt-holes shall be drilled and located symmetrically off the centerline. The bolt hole circle shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

1.18.2. Materials

The materials used in the manufacture of pipes and fittings shall comply with requirements specified in IS 8329 and IS 9523.

1.18.3. Dimensions and Tolerances

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per the relevant tables of IS 8329 / IS 9523 for different class of pipes and fittings. Pipe class K9 or as per requirement, pipe nominal diameters of 450, 800 and 1000mm and standard length of 6m is recommended and other properties for pipes and fittings shall be as per IS 8329/IS9523. Each pipe supplied shall be of uniform thickness throughout its length. The tolerances for pipes and fittings regarding dimensions, mass, ovality and deviations from straight line in case of pipes shall be as per IS 8329 / IS 9523.

1.18.4. Testing

1.18.4.1. Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS 8329 / IS 9523.

The frequency and sampling of tests for each batch of pipes shall be in accordance with IS 8329. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS 8329 / IS 9523.

1.18.4.2. Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500. The test shall comply with the requirements specified in IS 1500 / IS 8329.

1.18.4.3. Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

1.18.4.4. Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS 8329 / IS 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with 700g hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

1.18.5. Joints

1.18.5.1. General

Jointing of DI pipes and fittings shall be done as per IS 12288 and manufacturer's recommendations. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. Rubber sealing rings / gaskets used for jointing shall be of SBR or EPDM rubber and conform to IS 638, IS 12820 and IS 5382.

1.18.5.2. Spigot and Socket joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS 12820. The gaskets / sealant used for joints shall be suitable for water conveyance. In jointing DI pipes and fitting, the contractor shall take into account the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that the rubber ring as per IS 12820 and IS 5382 is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier or as otherwise directed by the Engineer.

1.18.5.3. Gaskets for Flanges

The gaskets used between flanges of pipes shall be of SBR or EPDM rubber conforming to IS 638 of thickness between 1.5 to 3 mm suitable for conveyance of sewage and waste water and as specified by manufacturer.

1.18.5.4. Flanged joints

These shall be of PN 16 rating and shall comply with dimensions and drilling details as specified in IS 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All material shall be supplied by a reputed manufacturer and shall be approved by the Engineer. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The recommended bolting torque to be followed for assembling flanges shall be as specified in manufacturer's instructions. The practice of

fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified. They shall be coated with coal tar epoxy coating after tightening.

1.18.6. Coatings

1.18.6.1. General

Unless otherwise specified, DI pipes and fittings shall be Zinc coated with Bitumen over coating in accordance with following specifications. At buried DI pipes and fittings shall also have factory or site applied polythene sleeving. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected at site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

1.18.6.2. Zinc coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/ m³ in accordance with ISO 8179.

1.18.6.3. Bitumen coating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions. Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

1.18.6.4. Polythene Sleeving

Where polythene sleeving is specified to be applied in addition to bitumen coating above it shall comply with ISO 8180. Site applied sleeving shall be stored under cover out of direct sunlight and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions. Joints in the sleeving shall be properly overlapped and taped in accordance with manufacturer's instructions to provide in continuous sleeving.

1.18.7. Cement mortar lining

All pipes and fittings shall be internally lined with cement mortar in accordance with ISO 4179 / IS: 11906. Cement mortar lining shall be applied at the factory in conformance with the above-mentioned standards. No admixtures in the mortar shall be used without the approval of the Engineer. Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer. Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be 5 mm for DN 450 mm pipe; and 6 mm for DN 800/1000 mm pipes, respectively.

1.18.8. Marking

Each pipe and fitting shall have cast, stamped or indelibly painted on it the following appropriate marks:

- a) The nominal diameter.
- b) Class reference.
- c) Mass of pipe.
- d) Date of manufacture and
- e) Manufacturer's name, initials or identification mark.

Marking shall be done as per IS 8329 and IS 9523.

1.18.9. Third party Inspection of the pipes is mandatory in the manufacturing unit. The test certificate shall be produced in this effect by the contractor at his own cost. The agencies performing the TPI shall be enlisted in the list of PCMC.

1.1. TRANSPORTATION, HANDLING AND INSPECTION.

Transportation – Pipes should be loaded in such a way that they are secured and that no movement should take place on the vehicle during transit.

The pipes should be loaded on vehicles in pyramid or straight sided information. In case of pyramid loading, the pipes in the bottom layer should be restrained by the use of broad wooden wedges secured to the vehicle being loaded. The pyramid is to be formed by resting pipes between the pairs of pieces in the preceding layer with the sockets in layers reversed. Straight sided loading may be used with supports along the sides of the vehicles. The use of straight sided loading is advantageous for utilizing full capacity of the vehicle.

Off – Loading – Cranes should be preferred for off – loading. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used.

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently with safety. The pipes should be lifted smoothly without any jarking motion and pipe movement should be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.

Where the crane operator does not have a clear view, he should be guided by the personnel supervising the operation. When cranes are used, the whole sequence of operation should be carried out smoothly and without snatch. Properly designed hooks and adequate stead ropes are essential. The hooks should be of suitable shape to ensure positive engagement when entered into the ends of the pipes and then should pass over any protective packing fitted around the pipe ends.

The use of slings passed around bundles of pipes is not recommended because bundles become unstable as the sling is drawn tight or released. However, when it is necessary to use the central slinging method for lifting single pipe, a broad webbing sling is recommended which minimizes the risk of the pipe slipping. Chain slings may slip and are dangerous.

Staking – Pipes being taken to a stock ground for storage and held pending further distribution should be arranged into stacks. The first layer of pipes should be laid on a firm's formations consisting of solid timbers set level on the ground. Subsequent layers should be placed according to the method of staking adopted. Care should be taken so that the pipes do not rest on their sockets. The height of any stack should not exceed 2 m.

Methods adopted for staking pipes are described in above paragraph.

Square Stacking

In square stacking method, second and subsequent layers are set at right angles to the previous layer with spigots and sockets alternating in each layer and sockets project beyond spigot end. The pipes rest directly upon those beneath it and care is needed in placing to prevent damage.

Parallel Stacking with Timbers

All the pipes are parallel with the sockets of successive layers reversed end-to-end with sockets projecting beyond spigot end.

Timber battens, placed about 600 mm from each end at right angles to the pipes, are used to separate the successive layers. Wedges at both ends of each batten prevent pipe movement.

Nested Stacking (Pyramid Stacking)

Nested stacking consists of placing each pipe between the two pipes underneath it, with the sockets being all at one end of each layer and layer should be firmly anchored to prevent the stack collapse.

Stringing

Stringing consist of placing pipes on the ground in line ready for laying. Care should be taken to prevent damage during this operation.

Pipes and fittings / specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by Engineer and as specified by manufacturer. Contractor shall be responsible for the safety of pipes and fittings / specials in transit, loading / unloading. Every care shall be exercised in handling pipes and fitting / specials to avoid damage. While unloading, the pipes and fittings / specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes and/or by any other approved means. Padding shall be provided between coated pipes, fittings / specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only.

The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for replacement. Any pipe which shows damage in the opinion of Engineer shall be discarded and replaced by new one. Dragging of pipes and fitting / specials along concrete and similar pavement with hard surfaces shall be prohibited.

1.1. INSPECTION OF PIPES: -

The pipes shall be got inspected through EIL/SGS/RITES. All charges of EIL/SGS/RITES inspection shall be borne by the contractor. The testing shall be done as per relevant IS.

Mode of Payment: - On receipt of the pipe on site 85% payment shall be released and remaining 15% percent payment will be released after Laying & satisfactory hydraulic testing.

1.1. Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at bottom layer to keep the stack shall be in pyramid shape or the pipes laid length wise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5m Fittings / specials shall be stacked under cover and separated from pipes. Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. In the field the rubber rings shall be handled such that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

1.1. Laying

1.22.1. Trenching

Trenching includes all excavation, which is carried out either by hand or by machine and shall be carried out in accordance with all general requirements of civil works specifications mentioned for sub work. In addition to those general requirements, the following requirements shall apply to pipelines:

The excavation shall be done such that it does not get far ahead of laying operations. Before excavating trench, the alignment of pipeline shall be approved by Engineer. Cutting's length and other appurtenances shall be provided to suit detailed pipe configurations required. To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian standards and the rules and regulations of local authorities in regards to safety provisions shall be observed. The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by Contractor and approved by Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organizations or otherwise as Engineer may direct.

Contractor shall take into account additional excavation if any as Engineer may require in order to locate the position of water pipes, drains, sewers etc., or any other works which may be met with, in or about the excavation of trenches while quoting the rates for excavation of trenches while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work. Any damage to the service lines shall be borne by Contractor. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure pipe line of water, gas, sewage etc.

1.22.2. Bedding

The depth and type of bedding shall be as shown on the Drawings and the requirements specified in subwork.

1.22.3. Laying of Pipes and Fittings

Pipes and fittings shall be laid in accordance with IS12288 and manufacturer's instructions. In addition, the requirements specified in Part-6 Clause 6.9.5 shall also be followed.

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipeline of water, gas, sewage etc. After excavation of trenches pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Engineer. Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings shall be made by Contractor. In no case pipes and fittings shall be dropped. Slings of canvas or equally non- abrasive material of suitable width or special attachment to fit the ends of pipe and fittings/specials shall be used to lift and lower the coated pipes and fittings / specials. The pipes and fittings/specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene / dye on the inside of the pipe at the suspected spot. No sign of kerosene / dye should appear on the outside surface. Pipes and fittings damaged during lowering aligning shall be rejected by Engineer and shall be replaced by new one.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings / specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer. During the period that the plug's on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2° for 800 and 1000mm; and 3° for 350 mm diameter pipes. The cutting of pipe for inserting valves, fittings or specials shall be done in a neat and workman like manner by using tools and taking precautions as per manufacturers recommendations without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

1.22.4. Thrust Blocks and Anchor Blocks

Thrust blocks and anchor blocks shall be provided as per the design and drawing provided by the Engineer-in-charge.

1.22.5. Back filling

Trenches shall be back filled with approved selected excavated material only after the successful testing of the pipeline as directed by Engineer. Back filling shall be in accordance with requirements and as directed by the Engineer in Charge.

1.22.6. Pipelines Under Existing Roads

Pipelines laid along a road shall be laid in trench. The sewage rising mains shall be continuously ascending and shall not form many vertical kinks.

1.22.7. Reinstatement of Roads

Reinstatement of roads / footpath shall be done as per the requirements of local authorities.

1.1. Cleaning of Pipes and Fittings

Pipelines shall be cleaned of all dirt, debris, dust or other deposits before hydraulic test to the satisfaction of engineer. The requirements specified in sub work 1 shall be followed.

1.1. Hydraulic Testing

Pipelines and fittings shall be subjected to hydraulic pressure tests in the presence of the Engineer which shall comply with IS 12288 unless otherwise specified.

Testing shall be carried out in two stages:

- a) Test of sections as construction proceeds.
- b) A test of the whole of the pipeline on completion.

The Contractor shall equip himself with all plant, equipment, fittings and water necessary for the hydraulic tests. The Contractor shall submit to the Engineer, well in advance of the time of tests, details of his proposals, including the supply of water either by tankers or bore holes. No connections from the existing pipelines will be allowed, nor will any connections to the pipeline and pipe work which would involve cutting, tapping or altering the Permanent Works be allowed. Test gauges shall be of approved manufacture having dials at least 200 mm diameter, graduated such that the test pressure is at least 75% of the full-scale reading shall be used. If necessary different gauges shall be supplied for different pipeline sections. Two gauges shall be provided for the sole use of the Engineer and shall remain in Engineer's possession for the duration of the Contract. All gauges shall be dead weight tested and calibrated at the commencement of work and at regular intervals as required by the Engineer.

The contractor's arrangements for testing shall include a suitable means of quick installation and removal of the Engineer's gauges during testing.

1.24.1. Testing procedure

The Sectional Hydraulic Test shall be carried out after the pipeline section to be tested has been laid, jointed and back filled to a depth sufficient to prevent floatation, but leaving the joints exposed which have not been tested. The sections to be tested shall be to the approval of the Engineer and shall not be longer than 2000 m or 500 m when either the pipeline is laid adjacent to or underneath the carriage way or when section includes an air valve chamber. The joints between each tested section shall be left exposed until the pipeline has passed the Test on completion.

In addition to the above requirements the Contractor shall perform a hydraulic test on the first 200 m length of pipeline to be laid under the contract. This test shall be undertaken within one month of the Contractor commencing the laying of pipes. Should the pipeline fail the test or the Contractor fails to undertake the test, all laying and welding work shall come to a halt until that section of pipeline passes a hydraulic test.

Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the forces which will be exerted when the test pressure is applied. Testing against closed valves will not be permitted. Washout valves shall be fitted with blank flanges and these together with in-line valves shall be left open. Air valves already fitted shall be permitted to function during the test.

Proposals for testing where thrusts on structures are involved, even where thrust flanges on the piping are installed, shall be submitted, with the calculations of the forces to be carried, to the Engineer for approval.

The method of filling the pipeline with water shall be approved by the Engineer. The length under test shall be filled making certain that all air is displaced through an air valve installed at the top of the blank flange situated at the high end of the line. The length shall then remain under constant moderate pressure, 10 to 20 m head of water, for a period of several hours until the pressure can be maintained without additional pumping.

The pressure shall then be slowly increased at a maximum rate of 1 bar per minute to the full test pressure and pumping discontinued for 3 hours or until the pressure has dropped by 10 m, whichever occurs earlier. Thereafter pumping shall be resumed and continued until the test pressure has been restored. The quantity of water pumped restore the pressure shall be the measure of leakage from discontinuation of pumping until its resumption.

The pipe length shall pass the test if the leakage is not more than 1.079 litres per mm diameter per kilometer per 24 hours for each 100 m head of pressure applied and the full test pressure has been sustained for at least eight hours.

Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint the Contractor shall, at his own cost, replace the pipe, repair the pipe or re-make the joint and repeat the hydraulic test.

No pipeline shall be accepted until the leakage on any length is not more than the rate of leakage specified above and all sources of leakage have been rectified.

The Test on Completion shall be carried out after all the pipeline sections have been satisfactorily tested and the joints between each section completed to provide a continuous test length between contract interfaces. Pipelines shall be tested as above except where the Engineer issues such instructions as are necessary for testing parts of the works that have been designed for stresses limited by considerations other than those applying to the pipeline systems.

1.24.2. Test Pressures

Test pressures are to be measured in bars at the center of the blank flange situated at the lowest end of the pipeline under test. Unless otherwise specified or shown on the drawings pipeline test pressure shall be in accordance with the following:

DI pipe and fittings 16 bar

For testing of sections of pipeline containing air valve chambers the Contractor should verify from manufacturer that the air valves are capable of operating under and sustaining the test pressure.

1.1. Pipeline Disinfection

Upon completion of a newly laid main shall be cleaned, disinfected using chlorine solution in accordance with procedure specified in IS 12288. Alternative methods may be adopted with the approval of the Engineer. The chlorinated water shall stand in pipeline for a minimum period of 24 hours and all valves in the system shall be operated twice during this period.

The chlorinated water shall be neutralized and disposed off as directed by Engineer.

After final flushing and before the pipeline is placed into service, water samples shall be collected and tested for bacteriological quality and shall not indicate the presence of coliforms. If the initial disinfection fails to produce satisfactory results, disinfection shall be repeated and satisfactory samples are obtained.

The Contractor is expected to carry out the cleaning, disinfecting and dewatering work as a part of laying the pipes and his rates for laying the pipes should include the cost of cleaning and other related works.

1.1. Chamber Markings

Details like valve type, size, cistern number shall be painted on all valve chambers as directed by Engineer. Where valve chambers are flush with the ground, suitable marker posts shall be provided adjacent to the chambers at a suitable location with all details approved by Engineer.

In case of the pipeline laid above ground details such as chainage, invert levels of pipe saddle number culvert number, anchor / thrust block number etc., shall be suitably painted either on the pipeline or the supporting structure in distinct color.

1.1. Measurement and Payment

The measurement for pipes for items specified in Bill of Quantities shall be on running of the net length along the center line of the pipe excluding the length of specials and appurtenances. Payment for pipes shall be made in running meters after production of test certificates specified and directed by Engineer.

Specials shall be paid separately on the basis of each piece used. For the payment purpose, flanges shall be either included in or excluded as described in the Bill of Quantities. However, material such as nuts, bolts and washers, etc., shall be included in the respective items.

Valves and Expansion joints shall be paid on number basis after erection and successful testing.

Payment for laying the pipes and specials shall be made 85% ON SUPPLY, 5% ON LAYING AND 10% ON TESTING .

Item No.24: - Lowering laying and jointing with SBR rubber gaskets C.I. S/S pipes of various classes with CI / MS specials of following diameter in proper position, grade and alignment as directed by Engineer-in-charge including conveyance of material from stores to site of work, including cost of jointing materials and rubber rings labour etc. complete.

Lowering, Laying and Jointing as per Item No. 23, Sub work No.2.

Mode of Payment: -

The item shall be measured and paid for one running meter length of actual pipeline laid.

Item No.25: - Providing and supplying ISI Standard DI Specials and fittings with sealing rubber gasket of SBR complete with cast iron follower gland and MS nut bolts coated or otherwise protected from rusting and suitable for DI pipes including cost of labour material and transportation to stores loading unloading excluding GST lived by GOI & GOM in all respect complete as per IS- 9523. **80mm to 300 mm dia.**

The items include providing, supplying ISI Standard DI Specials and fittings with sealing rubber gasket of SBR suitable for diameter as required and of required thickness and including all materials labour charges with epoxy paint/ Cement Lining from inside and outside including all taxes (Central & local) Octroi if necessary, inspection charges, transportation to stores/ sites & stacking etc. complete. As per requirement a machine ends DI specials suitable for D. I. pipes will also be supplied under this item.

The mode of measurement of payment shall be on weight (Kg) basis.

Item No.26: - Dismantling dead pipeline of M.S./ R.C.C./ C.I./ P.S.C. and G.I./ A.C./ P.V.C./ S.W./ H.D.P.E. pipe including cost of necessary excavation and refilling of trenches, breaking the joints, lifting the pipes and stacking to the place as directed by Engineer-in-charge with all leads and lifts including cleaning the surface, etc. complete.

Dismantling of pipelines to be done as directed by Engineer in Charge

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one-meter basis.

Item No.27: - Providing and supplying in standard lengths H.D. Polyethylene Pipes, confirming to IS 4984 /14151 / 12786 / 13488 with necessary jointing material like mechanical connector i. e. thread / insert joint / quick release coupler joint /compression fitting joint or flanged joint excluding coupler/ specials, including transportation and freight charges, inspection charges, loading / unloading charges, conveyance to the departmental stores & stacking the same in closed shade duly protecting from sunrays & rains, excluding GST levied by GI & GOM in all respect etc. complete. As per IS:4984-2016(HDPE Pipes up to 110mm dia. shall be

The specifications for HDPE pipes of various diameters are confirming to I.S.4984 – 1995.

Grade of Raw Material

Raw material used to manufacture the HDPE pipes shall be pre compounded at manufacturing stage. PE 100 is resin proposed to be used for manufacturing of the pipes.

General: -

1) The material used for the manufacturer of pipe should not constitute toxic hazard, should not support microbial growth and should not give rise to unpleasant taste and odour or discoloration of water. Pipe manufacturer shall obtain a certificate to this effect from the manufacturer of raw material.

2) High density polyethylene (HDPE) used for the manufacture to designation PEEWA – 45 – T – 006 of IS 7328: 1992. HDPE conforming PEEWA – 45 – T012 of IS 7328: 1992 may also be used with exception that met flow rating (MTR) shall not exceed 1.10 g/10 minutes – In addition the material shall also conform to 5.6.2 of IS 7328: 1992.

3) The specified base density shall be 946.5 Kg/m³ and 946.4 Kg/m³ (Both inclusive) when determined at 270 C according to procedure prescribed in IS 7328: 1992. The value of the density shall also not differ than 3 Kg/m³

4) The melting flow rating (MFR) shall be between 0.41 and 1.10 (both inclusive) when tested at 1900 C with nominal load of 5 Kg & as determined by method prescribed in 7 of IS 2530: 1963. The MFR of the material shall also be within 20% of the value declared by the manufacturer.

5) The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 0.5% and dispersion of carbon black shall be satisfactory when tested according to the procedure described in IS 2530: 1963.

6) The percentage of the antioxidant used shall not be more than 0.3 percent by mass of finished resin.

Quality Assurance Certificate

Quality assurance certificate for the raw material proposed to be used for the project, from one of the certifying agencies such as Body coat or Slevan or Advantica or any other internationally reputed organization shall be submitted along with the supply.

The manufacturer should submit the above raw material certificates for proposed grade of material PE – 100 at time of supply of pipe.

Contractor shall submit the following Certificates from the manufacturer.

Pressure Rating

The pressure rating of HDPE pipes and specials shall be confirming to I.S. 4984:1995 for 6 Kg/cm² (working pressure) for material grade PE 100.

Colour of pipes

The Colour of the HDPE pipe shall be as specified in IS code is black. The pipe shall be designed for the temperature of 450 C maximum.

Reworked material.

The addition not more than 10% of the manufacturer's own rework material resulting from the manufacturer of pipes is only permissible.

Dimensions

The pipe dimensions shall be as per latest revisions and amendment of specified in standards IS 4984:1995. The pipes shall be supplied in straight lengths of 20 m. Short length of 3 m (Min) upto maximum of 10% of total supply will be permitted.

The internal diameter, wall thickness, length and other dimensions of pipes shall be as per relevant clauses given in IS 4984 applicable, for different class of pipes. Each pipe shall be of uniform thickness throughout its length. The dimension to tolerances shall be as per specified I.S. standards.

Performance requirements

The pipe supplied should have passed the acceptance tests as per clause given in specified IS standards. The manufacturer should provide the test certificates for the tests conducted, as required in specified standards along with the supply of pipes. These acceptance tests can be performed in the in-house laboratory of the pipe manufacturing factory of the successful Contractor. Third party inspection shall be carried from 1) M/s Central Institute of Plastic Engineering & Technology, Aurangabad. 2) M/s Dr.Amin Controler Pvt.Ltd, Mumbai 3) M/s WAPCOS Ltd., Gandhi Nagar shall have to submit to Department / Grampanchyat, after supply of pipe at site. Then only it can be measured and recommended for further payment.

Marking

As per the provisions of clause given in specified standards each straight length of the pipe shall be clearly marked in inedible ink/paint the following information shall be marked.

- a. ISI stamping with marking of IS 4984(or IS 14333)
- b. The manufacturer's name and /trade mark.
- c. Designation of the pipe as per IS 4984 (or 14333)
- d. Lot number /Batch number

BIS License

The pipe manufacturer who is going to supply the pipes for the project has to have a valid BIS license.

Bid without these licenses may be treated as non-responsive

Fittings/Specials

All HDPE fittings/specials shall be fabricated in accordance with IS : 8360 (Part I & III). PE Injection moulded fittings shall be in accordance with IS : 8008 (Part I to IX). All fittings /specials shall be fabricated or injection moulded at factory only. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer.

Fittings will be butt welded on to the pipes or other fittings by use of heat fusion.

Bends

HDPE Bends shall be plain square ended as per IS: 8360 part I & III specifications. Bend may be moulded shall be manufactured or fabricated from pipes elements.

Tees

HDPE Tees shall be plain square ended as per IS: 8360 Part I & II specifications. Tees may be equal tees or reduced bench off tees. Tees may be moulded or fabricated from pipes elements.

Reducers

HDPE Reducers shall be plain square ended as per IS : 8008 Part - I & VII Specifications.

Flanged HDPE Pipe Ends.

HDPE Stub ends shall be square ended as per IS : 8008 Part & VII Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

Slip on Flanged

Slip-on-flanges shall be metallic flanges covered by epoxycoating or plastic powder coating. Slip on flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges will be PN 10.

Welding

Procedure

Joining between HDPE pipes and specials shall be done as per the latest IS : 7634 Part II. Method of joining between the pipes to pipes and pipes to specials shall be with butt fusion welding using semi-automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding of HDPE pipes.

Normally butt fusion welding shall include following activities.

- Alignment of pipe on welding M/C
- Surface preparation for welding.
- Heating of pipe ends
- Holding pipe ends for welding
- Cooling etc.

Installation and Commissioning of HDPE PIPES

Installation

- a. Supplying, laying, jointing, testing and commissioning of pipes shall conform to relevant IS codes, as applicable.
- b. The alignment of pipelines shown in drawings of the tender documents is only indicative and the exact alignment will be as per drawings and /or as directed by the Engineer or his representative.
- c. The HDPE pipes shall be laid in accordance with the latest IS 7634 Part 2.

Hydraulic Testing of HDPE Pipe Line

- a. The Sectional Hydraulic Test shall be carried out after the pipeline section to be tested has been laid jointed and backfilled to a depth sufficient to prevent floatation.
- b. Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the forces which will be exerted when the test pressure is applied.
- c. Proposals for testing where thrusts on structures are involved even where thrust flanges on the piping are installed, shall be with the prior approval of the Engineer.
- d. The proper method of filling the pipeline with water shall be used. The length under test shall be filled making certain that all air is displaced through an air valve or any other appropriate mechanism. The test length shall then remain under constant moderate pressure as per testing method given in the IS 7634.
- e. As per IS code water required to built up allowable drop in pressure during test will be treated as a make up water.
- f. Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint, the Contractor shall, have to be repaired at his own cost, replace the pipe or repair the pipe or remake the joint and repeat the hydraulic test is the responsibility of the contractor. The additional payment will not be made.
- g. Test pressures are to be measured in kg/cm² at the centre of the bank flange situated at the lowest end of the pipeline under test.

HDPE pipes and Fittings

All the pipes specials and fitting of HDPE shall be supplied and shall be tested along pipeline as per relevant IS codes and specifications.

- h. Daily O & M of HDPE pipeline should be done & maintain by contractor for two years free of cost. No extra payment will be done by MJP for this.

The Following code shall be used for:

- a. Site Test Pressure: as per IS 7634 Part I.

Suitable section length shall be 500 to 800 m as directed by the Engineer in charge shall be taken for such testing from time to time during progress of the work and satisfactory test given for that section. All testing apparatus, gauges, connections, etc. and water required for testing shall be arranged by the Contractor at his cost. The MJP does not undertake any responsibility to supply water for testing, If there is delay in testing, the contractor shall refill the trenches for the time being and reopen them at time of testing at his own cost, failure of which shall entitle the MJP to do the refilling the reopening of trenches at the risk and cost of the contractor. If the trenches are filled due to any reason whatsoever before testing the contractor shall have to open for testing at no extra cost.

Satisfactory hydraulic test shall be recorded when the section under test shall withstand the pressure as specified by the Engineer in charge for about 15 minutes without operating the test pump. The test pressure being maintained at the specified figures during that 15 minutes interval.

The field pressure to be imposed should be not less than the maximum of following

- a) 1.5 times the maximum sustained operating pressure.
- b) 1.5 times the maximum static pressure in the pipe line.
- c) Sum of maximum sustained operating pressure and maximum surge pressure.
- d) Sum of maximum pipe line static pressure and maximum surge pressure. Subject to the maximum equal to the work test pressure to any pipe fitting incorporated.
- e) The field test pressure should wherever possible be not less than 2/3 rd work test pressure and should be applied and maintained for at least 15 minutes.

The test pressure shall be gradually raised at the rate of 1 Kg/ cm² /min. If the pressure measurement are not made at the lowest point of the section, an allowance should be made for the difference in static head between the lowest point and point of measurement to ensure that the maximum pressure is not exceeded at the lowest point. If a drop in pressure occur, the quantity of water added in order to re-establish the test pressure should be carefully measured. This should not exceed 0.1 lit/ mm of pipe dia. per Km. of pipeline per day for each 30 cm. head of pressure applied.

During testing if any joints are found leaking, they shall be repaired and /or redone by the contractor at his cost till the test is found satisfactory. Similarly, any pipes, collars, specials, show hair cracks, leaks etc. during testing the contractor shall replace them with sound pipes and specials etc. free of cost. The hydraulic test shall be given in presence of the Engineer in charge.

10% payment of total sub work of pipe line work shall be withheld till hydraulic test is given which shall be released only on giving satisfactory test.

Mode of Payment:

85% payment shall be released against providing HDPE pipes, after submitting third party inspection certificate from
1) M/s Central Institute of Plastic Engineering & Technology, Aurangabad. 2) M/s Dr.Amin Controler Pvt.Ltd, Mumbai
3) M/s WAPCOS Ltd., Gandhi Nagar 5% payment will be made after lowering, laying, jointing of pipes. 10% payment will be released after satisfactory hydraulic testing is given by contractor. The cost all types specials required as per site conditions is on Lum-Sum basis.

Item No.28: - Lowering, Laying and Jointing H. D. P. E./M. D. P. E. pipes in proper position including all specials by compression fitting/electrofusion and butt fusion jointing procedure as per relevant IS Code complete with all materials for jointing procedure like Electrofusion machine, Electric heater/ butt fusion welding machine with hydraulic jack, top loading clamp etc. and all labours as directed by engineer in charge as per IS-7634 Part II

Lowering, Laying and Jointing as per Item No. 27, Sub work No.2.

Mode of Payment: -

The item shall be measured and paid for one running meter length of actual pipeline laid.

Item No.29: - Drainage Drops - Providing following dia. S.W. or R.C.C. pipes in vertical drop arrangement including providing Following dia. S.W. and R.C.C. pipe fixed in B.B. masonry of manhole at the required level including providing Following dia. double tee, following dia. right angled bend, encasing in B.B. masonry 1:4 proportion all around the pipe, double tee, bend up to the foundation of manhole, jointing, cutting, filleting including neat cement rendering, plugging the opening with jungle wood knob complete as directed by Engineer-in-charge (0.60 M depth) excluding cost of chamber.

Drop arrangement shall be provided 0.80 m. height in manholes for R.C.C. pipes sewer line. S.W. pipes property connections etc. of diameter various from 150 to 300 mm. It is necessary to avoid splashing of sewerage on the man working in manhole. Through the manhole and the drops arrangement are separate item, the combined structure shall be homogeneous and bound to each other. The junction or joint of S.W. pipe for drop arrangement at manhole shall be done watertight in C.M. 1:1 with hard Crete. Stone ware pipes and specials shall be provided per standard specification No. Bd-V-39, Page No. 573 and latest I.S. Edition. The stone ware pipes and specials of various diameters shall be got approved from Engineer-in-charge. The contractor all submit the certificate of testing to the department at his own cost. The item includes providing and fixing S.W. Pipe of required diameter double junction Tee, right angles bend, blank flange cap with chain etc. at the site of work. After fixing in proper position, the joints of S.W. Pipes and specials shall be filled with spun yarn in C.M.1:1 with Hardcrete the open mouth of double tee junction shall be plugged so as to make the watertight. The cap with chain shall be provided to inner portion of SW. pipe in manhole. If there is any discrepancy in the enclosed drawing and the specification, the decision of Engineer-in-charge. Shall be final and binding on the contractor. The items shall be measured and paid for on meter basis. The depth of drop arrangement shall be measurable from invert of branch sewer to invert of main sewer. For excavation of pipe line trenches all the conditions under relevant item no. 2. will be followed. No Extra payment for excavation refilling, disposing etc. for drop arrangement shall be made to the contractor, it means the work of drop arrangement shall made during the construction of manhole etc. for encasing in M-150 the S.W. drop arrangement shall be made as, relevant items of schedule 'B' to the contractor.

Mode of Payment: -

The item shall be measured and paid on Nos. basis.

Item No.30: - Sewer line Installation and pressure Pipe Installation

Installation of HDPE product pipe by HDD method for on grade gravity sewer including preparing and setting up the plant and equipment, preparing new pipe-work material, making of entry & exit pits up to 1.5 meter depth, installing new pipe-work and commissioning system or making the system ready for commissioning by HDD operating including all related civil and mechanical works like excavation, shoring, strutting etc. drilling, stringing, reaming and pulling back the new pipe work on the designed bore path alignment, proper disposal of drilling fluid and back fill of site after complete all-inclusive as per IndSTT:101-2007:Code of practice for horizontal Drilling Technique suiting Indian conditions.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid for one-meter basis.

Item No.31: - Providing, supplying in standard lengths Polyethylene Pipes confirming to IS -4984/ 14151/ 12786/ 13488 with necessary jointing material like mechanical connectors i.e., thread/ insert joint/quick release coupler joint/compression fitting joint or flanged joint, including all taxes (Central and local) transportation and freight charges, inspection charges, conveyance to the departmental stores/ site and stacking the same in closed shade duly protecting from sunrays and rains, etc. complete.

Specifications same as per Item No. 27, Sub work No.2.

Item No.32: - Pushing of M. S. Pipe of following dia. for road crossing and Railway Crossing by push through method in all types of strata by using hydraulic jack and drilling machine of required diameter below M. S. Casing pipe lowering, laying, jointing of material, required welding machinery, tripod, chain pulley block, crane blower compressor, loading and unloading of machinery into the trench etc. transportation and dewatering etc. complete as directed by Engineer-in-charge but excluding cost of M.S. pipes.

The pipes pushed through the Railway / Road embankment should have minimum cushion of 1.20 M. above the pipes. The cautionary boards should be kept at sufficient distance from the point of crossing. The Pushing should be done with the use of hydraulic wets / winch machine as per standard procedure of railway Authority. Every precaution should be taken that while pushing no settlement takes place in the track / Road. The embankment should be protected with sand bags to avoid any slippage during working. The temporary trust only bed / thrust wall constructed for pushing should be dismantled after Completion of pushing work. The M.S. Pipe barrels shall be field welded with electric arc welding Machine. The item includes pushing of M.S. pipes, this includes the cost of thrust wells, supporting block in situ cement concrete of M 200 grade, necessary excavation & removing stuff through pipe while pushing, gas cutting, field welding in required number of runs, all materials labour required for pushing of pipes etc. complete as directed by Engineer In charge. The entire work should be carried as per the latest specifications of the Railway Department/Road Department for pushing of pipe work etc. Complete.

Item No.33: - Manufacturing, providing and supplying spirally welded / ERW/ SAW / fabricated M. S. pipes (Commercial Quality) including procurements of plates, gas cutting to required size rolling, tack welding assembling in suitable lengths to form pipes, welding on automatic welding machine and forming 'V' edge on both ends of pipes including railway freight, insurance, unloading from railway wagon, loading into truck, transport to stores, unloading, stacking, excluding GST levied by GOI & GOM in all respect etc. complete as per IS - 3589 and IS-5504 as applicable as per specifications (No negative tolerance in thickness is permissible).

- 1) Pipes to be supplied under this contract shall confirm to IS 3589-1991 Indian standard for, electrical Resistance welded of semiess or spiraly welded steel pipes for water Gas and sewerage (Subject to specific requirement given below).
- 2) In case Supplier proposes to supply pipe to the standards Superior to the above standard no weightage will be given while evaluating the bid & for payment.

3) Specific requirements.

a) Method of Manufacture.

Electric resistance welded (ERW).

b) Applicable standards (with latest Editions).

- ISO-1977 welded or seamless steel tubes for water, sewerage and Gas BS 3601-1974 steel pipes and tubes for pressure purposes, carbon steel ordinary duties.
- APL 5L-1980 Specifications for gas pipes IS 3589-1991 Specification for electrically welded steel pipes for water and Sewerage.
- IS 4711-1964 methods of sampling of steel pipes tubes and fitting.
- IS 1894-1972 Methods of tensile testing of steel tubes.
- IS 5822-1986 code of practice for laying and jointing M. S. pipes.

The items include transportation of M. S. Pipes by the Contractor at his own cost. Deptt. Will not be responsible for any breakages & damages during transportation. After completion of work, balance pipe will not be accepted by PCMC Payment of Balance pipes will be recovered as per the accepted tender rate, and the Contractor shall not insist PCMC to accept the remaining pipes.

1.1. TRANSPORTATION, HANDLING AND INSPECTION

1.28.1. Transportation: -

Pipes should be loaded in such a way that they are secured and that no movement should take place on the vehicle during Transit.

The pipes should be loaded on vehicle in pyramid or straight sided formation. In case of pyramid loading, the pipes in the bottom layer should be retained by the use of broad wooden wedges secured to the vehicle being loaded. The pyramid is to be formed by resting piped between the pairs of pieces in the preceding layer with the sockets in layers reserved. Straight --- sided loading may be used with supports along the sides of the vehicles. The use of straight – side loading is advantageous for utilizing full capacity of vehicles.

1.28.2. Off Loading

Cranes should be Preferred for off-loading, however for pipes up to 400 mm nominal bore, skid, timbers and ropes may be used.

When using mechanical handling equipments, it is necessary to employ, sufficient personal to carry out the operation efficiently and safety. The Pipes should be lifted smoothly without any jerking motion and pipe movement should be controlled by the use of guide rope in order to prevent damages caused by pipes bumping together or against surrounding objects where the crane operator does not have a clear view, He should be guided by the personal supervising the operation when cranes are used, the whole sequence of operation should be carried out smoothly and without snatch. Properly designed hooks and adequate studs, rope are essentials. The Hooks should be of suitable shapes to ensure positive engagement when entered in to the ends of the pipes and then should pass over any protective packing fitted around the Pipes Ends. Stacking Pipes being taken to a stock ground for storage and held pending further distribution should be arranged in to stacks. The first layer or pipes should be laid on a firm foundation consisting of

solid timbers set level on the ground. Subsequent layers should be placed according to the method of stacking adopted; care should be taken so that the pipes do not rest on their sockets. The height of any stack should not exceed 2 M.

1.28.3. Method adopted for stacking Pipes are described as Under: -

1.28.3.1. Square stacking

In Square stacking method, second and subsequent layers are set in right angles to the previous layers with spigots & sockets alternating in each layers and sockets projects beyond spigot ends. The Pipes directly rest upon those beneath it and care is needed in placing to prevent damages

1.28.3.2. Parallel sacking with Timber: -

All the pipes are parallel with sockets of successive layers reversed end to end with sockets projecting beyond spigot end. Timber battens placed about 600 mm from each end at right angles to the pipes are used to separate the successive layers, wedges at both ends of each batten prevent pipe movement.

1.28.3.3. Nesting stacking (Pyramid Stacking)

Nested stacking consists of placing each pipe between two pipes under Neath it with the socket being all at one end layer and layer should be firmly anchored to prevent the stack collapse.

1.28.3.4. Stringing: -

Stringing consists of placing pipes on ground in line ready for laying care should be taken to prevent damages during this operation.

1.1. INSPECTION OF PIPES

The pipes shall be got inspected through RITES. All charges of RITES inspection shall be borne by the Contractor. The testing shall be done as per relevant I.S.

If any damages / cracks are found in Pipes shall be rejected and the same shall be disposed off immediately from site of work at own cost of the Contractor The pipes supplied by through contractor at site of work shall be issued to the contractor on" Unstamped Receipt "The responsibility of security and safety shall still rest with the contractor till the pipes are consume at the site of work. If any storage is found the cost of short materials with penal rate shall be covered from the Contractors bill in single Installment without any prior intimation.

1.1. Mode of Payment: -

- 1) 90% payment will be released after receipt of materials on producing, manufacturers test Certificate to the satisfactory result as per ISI Specification.
- 2) 5 % payments will be released after lowering, laying Jointing welding of the pipes satisfactory.
- 3) 5 % Payment will be released after Pushing the Pipes satisfactory.
- 4) After Completion of work balance Pipe will not be accepted by Department.

Item No.35: - Utility Shifting

Repairing the damaged water supply pipe line of HSC, Electrical/ Telephone/ Other cable including cost of G.I. Pipe and cables with all connection material, labours etc. complete.

Repairing House Service Connection, Electrical Cables, Telephone Cable, Other Cables which damaged during laying of Sewer lines. This Item includes providing materials and labours etc. complete.

MODE OF MEASUREMENT AND PAYMENT

The item shall be measured and paid on Km. basis, only where laterals of Main Trunk Sewer Line are to be laid and repairing work is to carried out for HSC, Electrical/ Telephone / other cables in one Km. portion as directed by Engineer-in charge.

SUB WORK NO. 3 & 5: - Sewage Collection Sump/ Wet Well

Item No.1: - Designing (aesthetically), and constructing RCC ground service reservoirs / RCC sumps in M-300 mix of required capacity including excavation in all types of strata, foundation concrete, container walls, bottom slab top RCC roof slab / or dome, 20 mm thick cement plaster with water proofing compound in CM 1:3 proportion to inside face of the container, including epoxy paint from inside including refilling and disposing of surplus stuff within lead of 50 M, all labour and material charges, for laying and jointing of pipe assembly for inlet, outlet washout, over flow and bypass arrangement consisting of C.I. M.S. D/F. pipes, specials and valves of given diameters, providing and fixing accessories such as M.S. ladder inside and outside, C.I. Manhole frame and cover, water top slab, B.B. masonry chamber for all valves, ventilating shafts, including giving satisfactory hydraulic test and water tightness test as per IS code and providing three coats of cement paints to all exposed surface of structure including roof surface etc. complete as per design data, criteria, obligatory requirements and detailed specifications. Anti-termite treatment shall be given for underground portion of the structure.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Note: 1 The designing shall be in accordance with various relevant I.S. specification (I.S. 456/2000, I.S. 875 - 1987, I.S.3370-1965 or revised.)

2. Only M.S. bars grade I confirming to I.S. 432 part I or high yield strength deformed bars confirming to I.S. 1786 or I.S.1139 shall be used grade II M.S. bars shall not be used.

3. Entire structure shall be in M - 300 only.

4. The scope of pipe assembly work shall be up to 5 metres beyond outside face of the wall, cost of pipes valves and specials is not included in the rate but labour cost for laying and jointing is included.

5. The G.S.R. / Sump above 15 lakh litres capacity shall be in two compartments

6. The job includes designing the structure for uplift pressure and dewatering if required using entire execution and disposal of surplus excavated stuff with in lead of 50 metres as directed by Engineer in-charge.

7. G.S.R. outlets shall be with bell mouth of approved pattern in bottom slab and cost of designing bell mouth is included in the rate. Sump well includes cost of suction pit required at bottom.

8. For pipe diameters up to 300 mm only DI pipes and DI specials shall be used. For pipe diameters above 300mm, M.S. pipes and specials minimum 10 mm thick shall be used with proper anticorrosive epoxy treatment from inside and outside.

9. Above rates are applicable for all seismic zones.

10. 75%-part rate shall be payable for reinforcement, concrete and plastering items of all types of G.S.R.s. and sumps till satisfactory hydraulic testing for water tightness test is given and till that work shall be treated as incomplete

The intending tenderer should acquaint himself thoroughly with the site conditions as well as needs of OMC before tendering and designing the schedules. The contractor should make his own arrangement about probable depth and strata for resting foundations. This Depth is Depend on the Invert of Incoming sewer also. This needs proper attention

for depth calculation of Sewage Sump. The obligatory levels, locations, storage capacity and bearing capacity of Sump /GSR shall as shown in table below.

Details of levels, capacity, location etc.

S. No.	Location of Sump/ Sewage Collection Sump	Capacity In Litres	Avg. Ground Level M	Bearing Capacity In T/ M2	Min. Water Level M	Max. Water Level M
1.	SPS 1 & 2	Receiving chamber, Course Screen Channels (02 Nos.) & Sewage Collection Sump Collectively called as Raw Sewage Sump of Total capacity _____ Litres	As per Actual	20	Shall be Calculated by Bidder as per CPHEEO Manual	Shall be Calculated by Bidder as per CPHEEO Manual

Note: Contractor has to submit detailed RCC Design & get approval from Govt. Engineering College at his own cost (Designing, Providing & Constructing RCC Sewage Sump Own Design)

Receiving Chamber

The deep gravity outfall sewers will discharge the raw sewage into a Receiving chamber. The function of the Receiving chamber is to distribute the flow for process units. The Receiving Chamber shall be designed for peak flow. The Receiving chamber shall consist of sluice gates on upstream for flow regulation. In the sidewall of the Receiving chamber, sluice gates shall be installed such that it is possible to operate them manually, inspection as well as operation by standing on a platform constructed at a suitable elevation adjoining and circumventing the receiving chamber. The receiving chamber shall be of adequate size to meet the requirements of workability inside it. The receiving chamber shall be open to sky and shall be water tight to prevent seepage of the sewage out of the receiving chamber. The entire construction is in M30 grade concrete and as per IS 3370. RCC access platform minimum 1200 mm wide with SS 304 pipe railing as per specifications shall be provided on one side of the chamber:

Number of Units: 1 (One)

Detention period: 30 Sec at Peak Flow

Min Free board: 0.50 m above FGL

Coarse Screen Channels

One mechanical screen working and one manual screen standby of 20 mm clear spacing and each screen shall be provided of 100% peak flow capacity.

The mechanical and manual bar screens shall be made of 10 mm thick Stainless Steel (SS 304) flats respectively. The mechanical coarse screens shall be of Inclined Rake Type of 20 mm opening as per the specifications detailed elsewhere

in the tender. Bin and chute arrangement shall be provided to take the screenings to the screenings dropped from chute will be collected in a wheel burrow. Manually operated CI gates are provided at the upstream and downstream ends to regulate the flow.

Adequate RCC Platforms shall be provided at the upper level to enable operation. Railings shall be provided around the entire periphery of the platform. The entire structure is to be M30 concrete and as per IS 3370 including the platform. RCC staircase 1200 mm wide shall be provided for access from the ground level to the top of the unit & to the operating platform.

Number of Units	: Min.1 Mechanical (Working) + 1 Manual (Standby) each of 100% Peak Flow capacity
Approach Velocity at Average Flow (m/sec)	: 0.3
Velocity through Screen at Average Flow	: 0.6 maximum (m/sec)
Velocity through Screen at Peak Flow (m/sec)	: 1.2 maximum
Min Free board	: 0.50 m above FGL
Wheeled Trolley	: 1 No.

All other accessories, whether specified or not, but required for completeness of contract shall be in contractor's scope

Raw Sewage Pumping Station

3.1 Sump and Pumps

Sewage enters into wet well of the pumping station after screening. The wet well shall be circular in shape and shall be designed for average flow. The capacity of the wet well should be kept such that the detention time in the wet well shall be minimum 5 minutes of peak flow and the maximum detention time shall not exceed 30 minutes at average flow. The entire structure is to be M30 concrete and as per IS 3370 including the platform. Following criteria shall be considered to size the sump:

1. That the pump of the minimum duty/ capacity would run for at least 5 minutes considering no inflow or
2. The capacity of the sump is to be so kept that with any combination of inflow and pumping the operating cycle for any pump will not be less than 5 minutes and
3. The arrangement of the submersible pumps as per pump manufacturer's data i.e. spacing between pumps, minimum space between pump and wall etc.
4. The side water depth (live liquid depth) shall be minimum 1.5 meter. In addition to the above liquid depth an additional depression shall be provided to ensure adequate submergence of the pump as per the manufactures recommendations Pumping station should have a room adequate for installing electrical panels. Suitable arrangement should be provided for lifting of pumps.

5. The effective liquid volume shall be provided below the invert level of the screen chamber after leaving provision for a minimum of 0.1 m.

Necessary bypass arrangement shall be provided to be used during the shutdown of the plant.

IS: 3370 and IS: 4111 (part 4) shall be followed for the design and construction of wet well.

The pumps shall be Submersible raw sewage pumps with centrifugal, non-clog type design.

The speed of pump shall not be more than 1500 rpm. The impeller should be of a non-clog design with smooth passage and solid handling capability of 100 mm size.

The pumps will have automatic coupling arrangement at discharge end for removal and a guide pipe and chain in SS 304 will be provided for removal and lowering of pumps. Pump shall run smooth without undue noise and vibration. Vibration shall be limited as per BS 4675 Part I.

Minimum Retention Time : 5 minutes minimum at peak flow.

No. of Pumps for present Flow : Capacity with Suitable Head (4W+2S)

Type of Pumps : Submersible type non-clog design

Solid passage size : 100 mm max. Through Pumps

Insulation : Class F

Protection : IP-68

Wet well Specific Requirement, Material of Construction and Accessories:

i. Number of Units	: (1) One designed for peak flow
ii. Pumping Station Material of Construction	RCC Wet well / Sump
iii. Raw Sewage Pump House	: RCC above the Wet well to house the panel required for pumps. It shall be RCC (M25) Frame and Brick Masonry Structure equipped with Doors, Windows/Ventilators, etc. complete. Also, it shall be provided with Flooring, Internal and External Plaster with Painting. The size of the sump shall be suitable to accommodate the number of pumps required for operation with easy maneuverability.

The design shall be carried out in conformity with following IS code.

a) IS 456:2000

b) IS 3370 -Part I and IV

c) IS 875: 1987 Part I to Part IV

d) IS 11682:1985 for RCC staging of overhead tanks.

e) IS 1893:1984 with inclusion of seismic zones as per latest circular.

f) IS 1786 for cold worked steel high grade deformed bars (Tor steel of Fe-415 grade & mild steel grade-I shall only be used.)

g) IS 13920:1993 -for ductile detailing, applicable for RECIRCULATION SUMPS under seismic zone III, IV and V. (Recent editions of IS shall be referred.)

h) B.S.I. publication S.P. 34 (S and T) 1987.

i) IS:13928: Ductile detailing of RCC structure.

1.4 This not on design will be subjected to through check by the Engineer-In-Charge of the owner and the tender will be accepted and work order issued by the competent authority only after verification that the design to be offered will fulfil the requirements of the design as per tender specifications.

SCHEDULE OF INTERMEDIATE PAYMENTS FOR SUB-WORK OF COLLECTION SUMP

Sr. No.	Payment Stages	%
1.	On Approval of Design	2%
2.	Excavation and PCC	5%
3.	On completion of Bed concrete & Footing	10%
4.	Vertical wall half height	17%
5.	Vertical wall Remaining height	18%
6.	Roof slab	10%
7.	On supply pipes valves and specials	15%
8.	Plaster finishing	5%
9.	On erection of pipes valves and constructions of chambers	3%
10.	Hydraulic testing	10%
11.	Other Miscellaneous items as per A/T including painting water level indicator, lighting Conductor, M.S. / SS ladder and nameplate etc.	5%
	Total	100 %

Note: 1) As provision for hydraulic testing is made in Sr. No. 10 above no further deduction from any of the other percentages is necessary towards hydraulic testing.

2) This is tentative and is to be approved by competent authority by contractor.

Specifications for Sewage Pumping Stations
(Civil Works)

DESIGNING , PROVIDING AND CONSTRUCTING PUMPING STATION

This work includes providing and constructing Sump and Pump House of size mentioned along with all the ancillary items related as specified in Schedule 'B' the quantity of ancillary items are worked out on the basis of structural Design and hydraulic of the project report However the contractor shall have to Submit his own structural design and drawings for sump and pump house which will Be got check and approved from the measurements of work for Payment shall be recorded as per approved design and drawing submitted by the Contractor the quantities of items on the of dosing and drawings submitted by The contractor and approved by the department shall not exceed the quantities Proposed in the schedule 'B'

Item No. :- Excavation for foundation in earth soils of all types, sand, gravel, ----- etc completed (Excluding back filling)

The excavation shall be done as per standard specification No.Bd-A-1,page No.259 or as per standard specification (Red Book)

The excavation shall be done to the required depth and section as per Design, drawing and as directed by Engineer-in-charge. Extra depth shall be made up Clear with concert or other suitable materials as directed by Engineer -in charge at the Cost of contractor the excavated material shall not be placed near than 3.00m. From the edges of excavated portion. no compensation shall be admissible the Contractor due to any delay as permission etc. After refilling of the trenches, the Balanced stuff should be disposed off as directed. Refilling and disposal will be paid Separately in relevant items, Necessary shoring and strutting of sufficient strength should be Provided to the excavated portion to prevent falling of sides. .

During execution of woks at all endangered where traffic Prevails, trenches shall be strongly fenced barricaded and marked with red lights During excavation, if masonry, structures, roots of trees etc, are with. The Same shall be removed without extra cost the loss to public or private utility Services such as telephone or electric cables/water mains/ or such other, if comes Across the excavation, shall have to

Contractor

No. of correction

Executive Engineer

be made good and working condition at the cost Of the contractor. All necessary arrangement for diversion of traffic should be made Before starting of excavation and all precautionary measures should be taken so as to Avoid accidents while works in progress.

The bottom of trench shall be leveled both longitudinally and transversely or stepped as directed by Engineer -in-charge. Measurement of work for Payment shall be made as per dimension shown in drawing or as directed by Engineer-in-charge.

Classification of material in excavation

The exact classification of the strata and road surfaces met during The excavation shall be done by the representative of Engineer-in-charge and Accordingly measurements shall by recorded under different items of excavation provided under Schedule 'B' of an 'agreement. The excavation in soft strata shall be carried out mechanically by blasting is not permissible in case shall be final. The strata classification and its quantity shown are indicative shown are only the contractor shall therefore carry out his own assessment regarding the strata at different depth at The site of work before submission of the tender.

Item No.:- Excavation for foundation in hard Murum and hard Murom with boulders -----etc completed (Excluding back filling)

The excavation shall be done as per standard specification No.Bd-A-2, page No.259 or as per standard specification (Red Book)The excavation shall be done to the required depth and section as per Design, drawing and as directed by Engineer-in-charge. Extra depth shall be made up Clear with concert or other suitable materials as directed by Engineer -in charge at the Cost of contractor the excavated material shall not be placed near than 3.00m.From the edges of excavated portion. no compensation shall be admissible the Contractor due to any delay as permission etc. After refilling of the trenches, the balanced stuff should be disposed off as directed. Refilling and disposal will be paid separately in relevant items; necessary shoring and strutting of sufficient strength should be provided to the excavated portion to prevent falling of sides. During execution of woks at all endangered where traffic Prevails, trenches shall be strongly fenced barricaded and marked with red lights. During excavation, if masonry, structures, roots of trees etc, are

with. The Same shall be removed without extra cost the loss to public or private utility Services such as telephone or electric cables/water mains/ or such other, if comes Across the excavation, shall have to be made good and working condition at the cost Of the contractor. All necessary arrangement for diversion of traffic should be made Before starting of excavation and all precautionary measures should be taken so as to Avoid accidents while works in progress.

The bottom of trench shall be leveled both longitudinally and transversely or stepped as directed by Engineer -in-charge. Measurement of works for Payment shall be made as per dimension shown in drawing or as directed By Engineer-in-charge.

Classification of material in excavation

The exact classification of the strata and road surfaces met during The excavation shall be done by the representative of Engineer-in-charge and Accordingly measurements shall by recorded under different items of excavation Provided under Schedule 'B' of an 'agreement. The excavation in soft strata shall be Carried out mechanically by blasting is not permissible in case shall be final. The strata classification and its quantity shown are indicative shown are only the contractor shall therefore carry out his own assessment regarding the strata at different depth at the site of work before submission of the tender.

Item No, :- Excavation for foundation in soft rock -----etc, completed.

The item shall comply as per relevant item of Schedule 'B', excavation shall be done as per

Standard specification No. bd-A4, A-6. On page No. 259 Respectively. All others specification shall be followed strictly as per items no. (1) Above.

Item No, :- Excavation for foundation in hard rock by control blasting -----etc, completed.

The item shall comply as per relevant item of Schedule 'B', excavation Shall be done as per standard specification No. bd-A4, A-6. On page No. 259 Respectively. All others specification shall be followed strictly as per items no. (1) Above.

Item No, :- Excavation for foundation in hard rock by Chiseling -----etc, completed.

The item shall comply as per relevant item of Schedule 'B', excavation Shall be done as per standard specification No. bd-A4, A-6. On page No. 259 Respectively. All others specification shall be followed strictly as per items no. (1) above.

1.1 General

The conditions/specifications laid down hereunder will hold good whether the excavation is to be carried out over areas for leveling foundations of structures, trenches for pipes or cables or any other type of work which involves earth work like the leveling of forming/embankments etc.

- a. Earthwork in excavation includes site-cleaning activities like removal of shrubs, loose stones, and rubbish of all kinds, interfering with the works and with complete removal of roots.
- b. The products of the above clearing operations shall be removed from the site, dumped, stacked at a place or places, burnt or otherwise disposed of as directed by the Engineer-in-Charge within the compound.
- c. A permanent base line and cross lines shall be established to serve as reference grid using MS plates, pegs, pins set in concrete or brick masonry pillars where they will be free from disturbances.
- d. A permanent bench marks or marks as required necessary for the works connected to the nearest GTS benchmark shall be established for reference.
- e. Excavation shall be carried out in all types of soil like top soil, silt, sand, gravel, soft murum, clay, kankar, hard materials like disintegrated rock shale which can be removed by picks, crowbars and shovels. Soil/earth may contain boulders. Loosening of rocks include the other methods of excavation other than blasting such as chiseling, wedging line drilling to avoid shattering of rocks. The Engineer-in-Charge shall decide what method shall be adopted for removal of the hard rock.
- f. Excavation, whose sides are required to be maintained at a steeper slope than the stable slopes, will be required to be properly shored and strutted failing which the contractor will be required to execute the work by open cutting by the approval of Engineer-in-Charge.

- g. Negligence on account of this leading to any mishap will be entirely the responsibility of the contractor.
- h. Please also refer the specification for excavation in the subwork of 'sewerage collection system'; specifications for item no. 3 to 6.

1.2 Drainage in the vicinity of excavation

- a. The contractor shall control the drainage in the vicinity of the Excavation so that the surface of the ground will be properly sloped to prevent surface water running into excavated areas during construction. Arrangements shall be made for preventing rain and other extraneous liquids entering the excavated parts. Seepage water shall be directed to flow away from the trenches by gravity. If any pumping is required to keep the trench and the exposed areas dry for further work the same shall be done by the contractor at his own expenses.
- b. The rates quoted by the contractor shall be deemed to be inclusive of all the above costs or charges for stipulations stated above.
- c. Excavated material shall not be deposited within 1.5 meters from the top edge of the excavation.
- d. The contractor shall remove the excavated material to spoil heaps on the site or transport the same to a place as directed by the Engineer-in-Charge.
- e. If the bottom of the excavation is left exposed by the contractor and in the opinion of the Engineer-in-Charge it has become deleteriously affected by atmospheric changes or affected by water then the contractor shall remove at his own cost such portions of the affected foundations and shall make good by filling with lean concrete or with compacted sand as directed by the Engineer-in-Charge.
- f. Where Excavation is made in excess of the depths required as shown in the drawings or as directed by the Engineer-in-Charge the contractor shall at his own expense fill up to the required level with lean concrete or well compacted sand as decided by the Engineer-in-Charge.

- g. Loose, soft or bad soil encountered in Excavation at the required depth on Engineer-in-Charge's directions shall be excavated to the firm bed and the difference of levels between the required level and the firm bed shall be filled up or dealt with as directed by the Engineer-in-Charge.
- h. Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed by him. Same shall be applicable for any antiques/treasure found during excavation.
- i. Any public utility services/facilities like water supply lines, gas supply line, sewers, telephone/electric cables poles etc. met with during Excavation shall not be damaged and no disruption is caused to the utility service on account of damages caused by the contractor. Such facilities shall be properly supported in their original positions by giving signs, suspension beams etc. as contractors own expenses.
- j. The contractor shall not undertake any concreting or constructing work of any nature on the excavated surfaces until approved for the same is given by the Engineer-in-Charge.
- k. The contractor shall be solely responsible for the protection of adjoining properties from damages that may be on account of excavation close to the properties whether the property belongs to government or to a private party.
- l. The contractor shall make all arrangements for proper warnings like providing fences, danger flags, barricading, night warning lights, watch and ward etc, to caution the public as well as the laborers engaged by him about the dangers that may be involved by excavation of trenches, pits, foundations etc. Safety code for excavation work IS: 3764-1966 shall be rigidly followed unless instructed otherwise by the Engineer-in-Charge.
- m. Any useful material obtained during excavation shall be stacked as directed by the Engineer-in-Charge and will be the property of the department. The decision of the Engineer-in-Charge in this regard shall be final and binding on the contractor.
- n. Any material used by the contractor out of the Excavated stuff in lieu of his own materials shall be charged to the contractor at the market rates.

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1.3 Excavation in trenches and cable ducts.

- a. Excavation as required in trenches, cable ducts, for manholes, other overflow structures, cross drainage works, extra depths for joints of pipes shall be carried out as shown in the drawings/directed by the Engineer-in-Charge.
- b. For deep foundations necessary shoring and strutting shall be executed as directed by the Engineer-in-charge. If additional slopes are to be provided where vertical cuts are not possible the same shall be executed without any additional cost. The rates quoted shall be deemed to be inclusive of all such extra work.
- c. The trench shall be kept perfectly dry by preventing the extraneous water entering the pits and also wherever necessary by pumping at the cost of the contractor. No additional cost of dewatering shall be payable unless there is an item specifically included in this sub work.
- d. The trenches after laying, jointing and testing of pipes/cables are to be back filled. The trenches shall be filled with the excavated material if found suitable as directed by the Engineer-in-Charge.
- e. All surplus soil/earth shall be transported and disposed of as directed by the Engineer-in-Charge. Boulders, sharp objects, brickbats, roots of trees, rubbish, rubble etc. shall not be used for back filling. The back filling shall be done very carefully so as not to damage the pipes/cables or disturb the alignment levels of the pipes/cables. The back filling shall be done in layers on both sides of the pipes, watered, and compacted by ramming to a dense layer. The thickness of each layer shall not be more than 15 cms. Special care shall be taken to avoid unequal pressures and not to disturb the pipe.
- f. In case the excavated material falls short of requirement the back fill soil/earth shall be taken from borrow pits approved by the Engineer-in-Charge. The rates quoted by the contractor shall be deemed to be inclusive of all such works.
- g. Sight rails and boning rods are to be used at regular intervals as directed by the Engineer-in-Charge to excavate the trenches true to line and grade.

1.4 Back filling / Earth filling

- a. Back filling of earth around liquid retaining structures and pipes shall be done only after the water-tightness test is done to the satisfaction of the Engineer-in-

Charge. Selected earth from the excavated earth shall be used for back filling / embankment.

- b. Care shall be taken to see that unsuitable soil/earth does not get mixed up with the material proposed to be used for filling.
- c. Regarding the soil/earth to be used for back filling the contractor shall have the prior approval of the Engineer-in-Charge.
- d. Backfill shall be placed in successive horizontal layers of loose material not more than 15 cm thick. The material shall be brought to within + or - 2% of the optimum moisture content as described in IS: 2720 (Part VIII) after adjusting the moisture content, the layers shall be thoroughly compacted with such equipment. as may be required to obtain a density equal to or greater than 95% of maximum laboratory dry density of the soil.
- e. Successive layers of filling shall not be placed until the layer under construction has been thoroughly compacted to satisfy the requirements laid down.

1.5 Filling and Embankment

- a. The area where filling or embankment is to be carried out shall be cleared from loose material and the virgin soil shall be exposed. All shrubs and vegetation with roots are cleared. All soft patches shall be removed and filled with selected soil/earth and consolidated. Exposed soil/earth shall be consolidated properly to obtain 95% of maximum laboratory dry density of the soil.
- b. Approved filling material shall be uniformly spread in layers not exceeding 20 cms in loose depth. All clods, lumps, etc shall be broken before compaction.
- c. Successive layers of filling shall not be placed until the layer under construction has been thoroughly compacted to satisfy the requirements laid down in these specifications.
- d. The contractor shall give the samples of the earth he proposes to use for back filling for testing, if required or directed by the Engineer-in-Charge along with the following characteristics of the soil/earth.
- e. Only earth having plasticity index less than 20 shall be used.
- f. Soil/earth having laboratory maximum dry density of less than 1500 kg per cubic meter shall not be used

- g. If the layer fails to meet the required density it shall be reworked or the materials shall be replaced and method of compaction altered as directed by the Engineer-in-Charge to obtain the required density.
- h. If any test indicates less than the specified degree of compaction the Engineer-in-Charge may require all the fill placed; subsequent to the latest successful tests to be removed and compacted and compaction procedure to be done once again to obtain satisfactory density.
- i. The contractor shall perform all necessary tests to determine optimum moisture content and the degree of compaction. He shall furnish the results to the Engineer-in-Charge.
- j. Prior to rolling, the moisture content of the material shall be brought to within +2% of the optimum moisture content as described in IS-2720 (part VIII). The moisture content shall preferably be on the wet side for potentially expansive soil/earth. After adjusting the moisture content as described in this clause, the layers shall be thoroughly compacted by means of rollers till 95% of maximum laboratory dry density is obtained.
- k. If the layer fails to meet the required density it shall be reworked or the materials shall be replaced and method of compaction altered as directed by the Engineer-in-Charge to obtain the required density.
- l. The embankment shall be finished to the alignment levels and grades, cross sections, dimensions shown in the drawings or as directed.
- m. If sand filling is specified in the tender for filling the trenches, plinth or foundations the sand used shall be hard, free from inorganic materials and deleterious materials and approved by the Engineer-in-Charge. Filling shall be carried out in layers not exceeding 15 cms in loose depth and flooded and tamped till it meets the approval of the Engineer-in-Charge.
- n. The contractor shall perform all necessary tests to determine optimum moisture content and the degree of compaction. He shall furnish the results to the Engineer-in-Charge.

1.6 Shoring / Strutting / Timbering.

- a. When the depth of foundation or pipe trench is great and the soil/earth is soft and generally for depths more than 1.5 m. Stepping, sloping and or paneling and strutting of sides shall be done as directed by the Engineer-in-Charge. The decisions regarding the positions and depths at which and what type of precautions are to be provided shall be decided by the Engineer-in-Charge.
- b. It shall be the responsibility of the contractor to take all necessary precautions or steps to prevent the sides of trenches from collapse. The contractor shall be responsible to make good any losses or damages caused to execute works, life and property due to his negligence.
- c. Deep excavation shall be inspected after every rain, storm, or other hazards and if necessary the precautions required shall be augmented.
- d. Planking and strutting shall be either "Close" or "Open" type depending upon the nature of the soil/earth and depth of excavation etc.
- e. The timbering shall be of sufficient strength to resist earth pressure and ensure safety to the adjoining property and to persons. Where the excavation is subjected to vibrations due to machinery, vehicles, rail traffic, blasting and other sources, additional bracings shall be provided.
- f. Generally the specifications and sizes and spacing of sheeting, walers and struts used for timbering of different depths shall be as given in the IS: 3764-1965 Safety code for excavation work unless otherwise specified in the tender else where. Shoring shall extend 30 cms, above the vertical sides.
- g. Withdrawal of timbering shall be done very carefully to prevent collapse of the sides of excavation and any damage to the work executed.
- h. Open timbering shall be provided wherever the Engineer-in-Charge directs, where the trenches are not close to any buildings/property/structures. In open timbering the trench shall be protected by covering $\frac{1}{3}$ the surface area by planks.

Important Notes

1. The bottom of Excavation shall be trimmed to the required levels and when carried below such levels, by error, shall be brought to level by filling with lean concrete of grade 1:4:8 or as specified at the contractor's cost and nothing extra shall be paid to the contractor on this account.

2. The contractor shall be responsible for assumptions and conclusions that he may make regarding the nature of materials to be excavated and the difficulty in making and maintaining the required Excavation and performing the work required as shown on the drawing and in accordance with these specifications. Cofferdams, sheeting, shoring, bracking, draining, dewatering, etc. shall be furnished and installed as required and the cost thereof shall be included in the rate quoted for the item of excavation. The contractor shall be held responsible for any damage to any part of the work and property caused by collapse of sides of Excavation. Materials may be salvaged if it can be done with safety for the work and structures, as approved by the Engineer-in-Charge. However, no extra claim shall be entertained for material not salvaged or any other damage to contractor's property as a result of the collapse. He shall not be entitled to any claim for re-doing the excavation as a result of the same.
3. The excavation for foundations shall be carried out carefully, creating least disturbance to the founding stratum. The founding stratum should be blended by the concrete layer immediately after exposure so that it does not lose its strength on exposure to air and water.
4. Where excavation requires bracing, sheeting, or shoring etc, the contractor shall submit to the Engineer-in-Charge, drawings showing arrangement and details of proposed installation, and shall not proceed until he has received approval from the Engineer-in-Charge.
5. The contractor shall have to constantly pump out the water collected in pits due to rainwater, springs etc. and maintain dry working conditions.
6. For the purpose of excavation in earthwork, all types of soil including kankar, murum, single and boulders without binding matrix are included.
7. All excavated material obtained as a result of over excavation for which payment shall not be made, and that shall also be transported and disposed off as directed and at places shown by the Engineer-in-Charge, at no extra cost to the department within plot boundary.
8. All excavated materials obtained from excavation shall remain in the department's property. The useful portion as decided by the Engineer-in-Charge, shall

be separated from the useless ones and deposited in regular stacks at places indicated and as directed by the Engineer-in-Charge.

9. In no case the excavated soil shall be stacked up to a distance of 1.5 m from the edge of excavation or one-half the depth of excavation whichever is more.

10. IS Codes

11. Some of the important relevant applicable codes for this section are IS: 1200 (Part-I)-Method of measurement of building and civil engineering works and earthwork

12. IS: 3764 - Safety -code for excavation work

13. IS: 4701 - Code of practice for earthwork on canals

14. Cradle and Manholes for collection sewer line shall be as per CPHEEO Manual.

Items No. :- Filling in plinth and floors with contractors Murom etc, completed .

The specification provided in the subwork for Sewerage collection system shall be referred This item shall be done as per standard specification No.-A-11 page No.263 for bedding and refilling of teach shall only be used the refilling shall be done in 15 to 20 cms thick layer. Each layer should be watered and compacted properly by engineer-in-charge.

Item no. :- Disposing of excavated stuff etc. Complete.

1) After refilling of trenches, surplus excavated stuff remaining at the Site of work have to be disposed off at suitable places with in one km distance as Directed by Engineer-in-charge2) Surplus excavated materials is the property of MJP and there and therefore Contractor is not empowered to sell these excavated materials to any other agency.

3) This disposal will not be considered for initial 50m. lead from edge Of trenches and so will not be paid for.

4) The materials shall be conveyed by means of suitable devices.

5) The material conveyed to place of disposal shall either be stacked Or spread as directed by Engineer-in-charge of his representative.

6) The route for operating and maintenance, payment of any royalties, Compensation to land owners and for damages if any etc. during the process of

Conveyance etc shall be the entire responsibility of the contractor.

- 7) this item includes all labors materials and equipments Required for Loading conveyance, unloading, stacking or spreading the material.
- 8) The tender rate shall be for one cubic meter of excavation quantity Conveyed to the to the place of disposal.
- 9) The quantity conveyed and disposed off shall be calculated from the Trench excavation after deduction of quantities for bedding concrete or any other Refilled material and balanced net excavation quantity will be payable under this items.
- 10) The excavated stuff shall be used for construction of road as per Item No of Schedule 'B'

Item, no. :- Providing and casting in situ P.C.C. 1:2:4 etc complete

The specification provided in the subwork for Sewerage collection system shall be referred

This shall comply as per standard specification no. Bd-E-1 on page No.287 or latest edition. Wherever the concrete is to be laid in trenches the trench shall be Cleaned watered and compacted before placing. The sub soil water which met shall Be removed and the trench shall be kept dry during and after two hours of placing of concrete, for more depth of P.C.C. Mechanical vibrator shall be used for compaction by the contractor. For materials such as cement, sand, coarse aggregate shall be used as described in specification for item no.

Items No. :- providing dry rubble stone soling -----etc.complete.

This item shall be executed as per detailed specification No.Bd-A-12 On page No. 264 for trench, plinth etc as directed by Engineer-in-charge.

Rubble stone shall be brought from approved quarry by the P.W.Departments including landing unloading stacking, lying, transportation Charges etc complete.

If the material is rejected by Engineer-in-charge or his representative it Shall be removed immediately from of work without any extra claims by the Contractor. Rubble stone soling shall be laid in layers including compaction

watering

Etc, as directed by Engineer-in-charge.

GENERAL

After the structural foundation, plinth construction and filling are completed, rubble soling of specified thickness shall be laid over the consolidated plinth filling, hand packed and compacted. The specification of the work as per Standard Specification Bd.A-12)

MATERIALS

The stones to be used shall be broken rubble with fairly regular shape and free from weathered, soft and decayed portion. The rubble shall be of sound stones of the type mentioned in the item and selected for their larger size. Stones shall be of the full height of the soling and the length and width shall not generally exceed 2 times the height. The stones to be used for wedging in the joints between larger stones, shall be chips of the largest size possible to fit in the interstices. All sound and suitable rubble obtained from the foundation excavation and approved by the Engineer shall be necessarily made use of first unless otherwise directed.

CONSTRUCTION

The bed on which rubble filling is to be laid shall be cleared of all loose materials, leveled, watered and compacted and got approved by the Engineer before laying rubble soling.

Rubble soling shall be laid to the specified thickness closely packed by hand and firmly with their broadest face downwards. The interstices between adjacent stones shall be wedged in with stones of the proper size and shape and well driven in with wooden mallets to ensure a tightly packed layer. Such wedging shall closely follow the placing of the larger stones. After hand packing and wedging, compaction of the soling shall be done thoroughly with logrammers. Adequate care shall be taken by the contractor while laying and compacting the rubble soling to see that the masonry or any part of the structure is not damaged. Rubble soling shall be started only after the masonry is fully cured.

BROKEN RUBBLE

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- c) Supplying broken rubble of approved of approved quality and size at site.
- d) All labour, material, tools and equipment for handling, laying, hand packing and compacting the rubble.

Any other incidental charges to complete the work as per sanctioned plan.

MODE OF MEASUREMENT & PAYMENT

Rubble soling shall be measured and paid in cubic meters limiting the dimensions to those shown on the drawings or as directed by the Engineer. The dimensions shall be measured correct to 2 places of decimals of a meter and quantities worked out correct to 2 places of decimals of a cubic meter. No deduction shall be made for voids.

Item No:- providing and casting in situ C.C. of trap/ granite/ quartzite/ gneiss metal ----- for R.C.C work etc. complete .

a) R.C.C Works

- 1) R.C.C works as per I.S.S. 456-2000 (latest edition) in R.C.C M-200 and M-250 with 12mm to 20mm gigue metal. The work shall also be carried out standard specifications No. Bd-F-3, Bd-F-22-23-24 on page No. 282,292 and 293 respectively.
- 2) R.C.C words in contact with sewage shall be executed as per I.S.S 3370 part I and II in R.C.C M-250 structure shall be finished with 20-mm thick Cement plaster in C.M.1:2 from inside in suplphate Resistant cement

1) MATERIALS

a) Cement.

43 grate Ordinary port land suplphate Resistant cement of MJP Approved Cement Company is company is only admissible.

b) Sand

This shall be clean, hard strong. Uncoated and well graded particles, the Sours of sand will be app.[proved by Executive Engineer, and in no case clay, silt, Admixtures will exceed 3% by weight or volume. Screening and washing shall be Done to stand to confirm specificatio0n. All sand shall pass through a screen with 3/16” mash only Kaman sand is permitted for R.C.C work of all grade for

Construction of RCC compound wall & others works quality of Wareham sand Shall only be used

c) Coarse Aggregate

All aggregates shall confirm to I.S 383-1963, IS 515-1969 and Should be as specified in I.S 456_2000, gigue of metal to be used shall be decided According to the type of works by the Engineer-in-charge the metal of approved Qualities to be brought from quarry approved by Executive Engineer, and P.W Department

d) Storage of Material

Sand and coarse aggregates shall be properly and separately stored on Site on hard ground so as to keep them safe from admixtures of foreign material such As clay, grass etc. it shall be as per I.S.456-2000.

e) Form Work

The steel centering shall be preferable. If wooden formwork is used, It shall consist of planks not less than 40 mm thickness and of strong props etc, This Shall be provided as per I.S 456-2000, clause of formwork. Timber used for Formwork shall be best hard wood and got approved by Engineer-in-charge. The item Is covered in the rate either for plain or R.C.C items for bottom slab, beams etc. P.V.C or plastic paper should be provided over the centering to make the same Watertight,

f) Separators

From bottom covers of beam, slabs .columns .vertical Walls, etc, Separators of pre-cast cement mortar block of suitable size will be used and tied to the Reinforcement by binding wires between layers of reinforcement. Separators or M.S Case required over to the bars will be ensured beyond bout as per I.S.456-2000 and I.S.3370-1965 part-II closure 7.2

g) Water

The water used be as per I.S 456-2000, approved measures for water Will be provided by the contractor the amount of water to be used will be decided by the workability and strength consideration which will be assured by the

Contractor.

g) Concrete mixing

Concrete shall be only machine mixed as per standard practice.

i) Placing

The form work shall be just moisture before placing of concrete the Concrete shall be placed in position within 20 minutes after adding water to the Concrete it shall be slowly deposited in its place in uniform layers it should Generally comply with I.S-456-2000 under clause No. 12.2

j) Tamping

While concrete is being placed in position it shall vigorously rotted And tamped by bars of appropriate size and other means to ensures dense concrete and Complete filling of forms. All around and in beaten the reinforcement the efficiency Of tamping and consolidation will be judged by complete the efficiently of tamping and Honey combing after removal of forms and any deficiency in this respect will result in Pulling down and redoing of affected work at the cost of contractor. For work of 'any magnitude or importance. Mechanical vibrators of both immersion and surface Type will be used as a rule; no work without mechanical vibrator will be permitted. When concrete is so vibrated the water cement ratio will least practicable.

k) Curing

All R.C.C works will be watered and kept constantly wet for at least 21 Days after casting by means of wet gunny gabs this operation shall start immediately. After initial set of concrete out satisfactorily and actual expenses made shall be recovered From The contractor, bill without any prior intimation.

j) Removal of forms.

Removal of forms will be carried out as below subjects to the prior approval Of Engineer-in-charge in writing.

a) Columns	:-	48 hrs, or as may be directed by the Engineer-in-charge.
b) Side of beam	:-	3 days,

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- c) Vertical wall : - 6 days.
- d) Bottom of slab/chhajja /canopies etc. : - 15 days.
- e) Bottom of beam : - 14 days. Unto 5m. Span
- f) Bottom of beam above : - 21 days.5 m, span
- m) Inspection

The work at each stage of operation i.e. completion of form work, Completion of assembling and placing reinforcement concreting removal of forms must be get inspected by the Engineer-in-charge or sub Divisional Officer in charge Of the work who will record necessary certificate to be done in the presence do Engineer In-charge or his authorized representative for major work such as centering Reinforcement of slab etc, shall be checked by the contractor designer before Concreting at the cast of contractor in the presence of Engineer-in-charge.

n) Finishing

All R.C.C. works will be finished as provided in the item concrete surface not in contact with form work and not subjects to any further finish will be finished smooth by a float to parents a uniform appearance. Surface to receive plaster or rendering will immediately on removal of

Forms be roughened by extensive hacking by a pointed tamping tool In all cases Where is it required to match with rest of the structure and present harmonious Appearance to be decided by Engineer-in-charge, such fishing included in the rate Of contract but will not be measured

o) Testing

i) Cubes

On any day when concerting of M-2000 and after mix is done for 4 Hours or 5 cum and more, concrete cubes of 15cm, x25cm, x15cm, shall be casted Per day equally spread over period of concrete. Every time seven cubes will be Taken for testing crushing strength three No's of cubes at 7 days and three No,s of Cubes at 28 days and one at 3 month the seventh cube will be kept as reserved to Be tested immediately after 28 days in case of the cubes tests 7 days 28 days

Show unsatisfactory result the casting and curing and testing of for moulds etc. The cost of contractor the contractor shall make his own arrangement for moulds etc. Number of cubes shall be taken out as per recent circular of M.J.P. or as directed by Engineer-in-charge., cubes shall be tested in the laboratory of government Engineer College at the cost of contractor & cube test certificated shall be produce by the Contractor at the time of submission of bill.

li) Mater

The contractor shall test the samples of cement sand coarse aggregate, Etc, required for R.C.C work at this own coat in the laboratory of Government Engineering college and submit the result to the department for according necessary Approval for the same various tests of each material shall be carried out as per I.S. and Recent circular of M.J.P. at the cost of contractor only.

lii) The minimum strength of 15x15x15cm. Concrete cube shall be As under.

Grade of concrete	7 days period	28days period	3Months, period
M-200 M-250	135 kg/sq. cm. 170 kg/sq.cm.	200 kg/sq.cm 250 kg/sq.cm.	220 kg.sq.cm. 275 kg/sq.c.m.
M-300	kg/sq.cm.	kg/sq.cm.	kg/sq.c.m.

The place where R.C.C is to laid shall be absolutely dry and it shall Be maintained dry from the time of starting the work unto six hours after the work is Completed (i.e. still concrete is set). A pit shall be excavated to such a size and depth that By dewatering from this pit will keep the ground water table below the level where Concreting is to carried out.The contractor should keep the pump of required ready at the Time of work.The rate of providing and laying concrete shall include expenditure or Keeping and maintaining ground dry.

General

In general RCC work is to be executed as per IS: 456-2000 or its latest revision. The water storage tanks/reservoirs shall be followed by IS: 3370 Part I to IV & latest revision. Steel reinforcement bars shall be of High Yield Strength Deformed (HYSD)/TMT steel bars as per IS: 1786 and shall be free from corrosion, loose rust scales, oil, grease, paint, etc. Wire mesh or fabric shall be in accordance with IS: 1566. The steel bar shall be capable of being bent without fracture. Bars shall be bent accurately and placed in position as per design drawing and bar bending schedule and bound together tight with 20 SWG annealed steel wire @ 10 kg/ton of reinforcement at their point of intersection. Formwork and shuttering shall be made with steel plate close and tight to prevent leakage of cement slurry, with necessary props, bracings and wedges, sufficiently strong and stable and should not yield on laying concrete and made in such a way that they can be slackened and removed gradually without disturbing the line, level and the shapes of concrete. For slab and beam small camber should be given in centering, 1 cm per 2.5 m with a maximum of 4 cm for quick drainage of water. Centering should not be removed before 14 days in general (4 days for RCC columns, 10 days for roof slab, and 14 days for beams). The centering and the form work shall be strong enough to take the shocks of the Mechanical Vibrators.

The grade of concrete to be used shall be as mentioned in specifications/shown on drawings.

Table - Minimum compressive strength of 15 cm cubes at 7 and 28 days after mixing, conducted in accordance with IS: 516 Class	Preliminary Test N/mm ²	Work Test N/mm ²	Test	Maximum size of Aggregate mm	Locations for Use
At 7 days	At 28 days	At 7 days	At 28 days		
M40	33.50	50.00	27.00	40.00	20
					As indicated in the

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						specifications or as re- quired
M35	30.00	44.00	23.50	35.00	20	-do-
M30	25.00	38.00	20.00	30.00	20	--do-
M25	22.00	32.00	17.00	25.00	20	--do-
M20	17.50	26.00	13.50	20.00	20	--do-

The coarse aggregate shall usually be 20 mm to 12 mm gauge unless otherwise specified. For heavily reinforced concrete members as in the case of ribs of main beams the maximum size of aggregate should usually be restricted to 5 mm less than the minimum clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement whichever is smaller.

Mixing is done in the same manner as in PCC.

Before laying the concrete, the shuttering shall be clean, free from dust, dirt and other foreign matters. The concrete mix shall be mixed in the drum for at least 2 to 2.5 minutes. The concrete shall be deposited (not dropped) in its final position. In case of columns and wall, it is desirable to place concrete in full height if practical so as to avoid construction joints but the progress of concreting in the vertical direction shall be restricted to 1.2 meter. Care should be taken that the time between mixing and placing of concrete shall not exceed 20 minutes so that the initial setting process is not interfered with. During the winters concreting shall not be done if the temperature falls below 4°C.

Concrete shall be compacted by mechanical vibrating machine until a dense concrete is obtained. The vibration shall continue during the entire period of placing concrete. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to the dry mixture. Over-vibration which will separate coarse aggregate from concrete shall be avoided. After removal of the form work in due time, the concrete surface shall be free from honey combing, air holes or any other defect.

Following Indian Standards as revised most recently along with amendments will be followed for the works included in the contract. IS:8112 Ordinary, Portland cement

IS:383	Coarse and fine aggregates from natural sources for concrete
IS:445	Portland slag cement
IS:456-2000	Code of practice for plain and reinforced concrete
IS:516	Method of test for strength of concrete
Methods of sampling and analysis of concrete	
IS:2386	Methods of test for aggregates for concrete (Part I to VI)
IS:3414	Code of practice design and installation of expansion and contraction joints in building.
IS: 3370 Part- I to IV	Code of practice for water storage Tanks

Concrete shall be laid continuously, if laying is suspended for rest or for the following day the end shall be shuttered and vibrated to achieve dense concrete and made rough after deshuttering for further jointing. When the work is resumed, the pervious portion shall be roughened, cleaned and watered and a grout of neat cement shall be applied and the fresh concrete shall be laid. For successive layer the upper layer shall be laid before the lower has set.

Pre-cast concrete shall be provided with lifting device.

Standards

Standards on special subjects have been mentioned elsewhere in this Para and also shall be followed.

Forms, false work or centering

Definitions

“Forms, formwork or shuttering” shall include all temporary moulds for forming the concrete to the required shape, together with any special lining that may be required to produce the concrete finish specified.

“False work or centering” shall consist of furnishing, placing and removal of all temporary construction such as forming, props and struts required for the support of forms.

Materials

Steel shuttering shall be provided as directed by the Engineer-in-Charge.

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Forms

All forms shall be of mild steel approved by the Engineer-in-Charge and shall be fabricated and prepared water tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other incidental loads incident to the construction operations. All form shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be specified hereinafter. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer-in-Charge shall order to stop the work until the defects have been corrected.

All formwork shall be approved by the engineer-in-charge before concrete is placed within it. The contractor shall be required to submit copies of his calculations of the strength and stability of the formwork or false work but not withstanding the Engineer-in-Charge's approval of these calculations, nothing shall relieve the contractor of his responsibility for the safety or adequacy of the formwork. Formwork shall be true to line and braced and strutted to prevent deformation under the weight and pressure of the unset concrete, constructional load, wind and other forces. The deflection shall not exceed 3 mm. Beam bottom shall be erected with an upward camber of 2 mm per meter of the span. The form work for a column may be erected. One side shall be left open and shall be built up in sections as placing of the concrete proceeds. Before placing the concrete, bolts and fixtures shall be in position, and cores and other devices, used for forming openings, holes, chases, recesses and other cavities shall be filled to the formwork. No holes shall be cut in any concrete unless approved. Approved mould oil or other material shall be applied to faces of formwork in contact with unset concrete to prevent adherence of the non-staying concrete. Such coating shall be insoluble in water, non-staying and non detrimental to the concrete and shall not be flaky or removed by wash water.

Tolerance in finished concrete

(As per IS code 456-2000, 0.1)

The form work shall be so made as to produce a finished concrete true to shape, lines, level, plumb and dimensions as shown in the drawing subject to the following

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tolerances, unless otherwise specified in drawings or directed by the Engineer-in-Charge.

For Deviation from specified

Dimensions of cross-section of columns

And beams = -6mm +12mm

b. Deviations of dimension of footings

(See Note)

Dimensions in plane = -12mm +50mm

Eccentricity = 0.02 times the width of footing in the direction of deviation but not more than 50 mm

Thickness = +/- 0.05 times the specified thickness

Note: Tolerances applied to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels.

False work and Centering

Detailed plans for false work or centering shall be supplied by the contractor if specifically asked for by the Engineer-in-Charge at least 14 days in advance of the time the contractor begins construction of the false work. Notwithstanding the approval by the Engineer-in-Charge of any designs for false work submitted by the contractor, the contractor shall be solely responsible for the strength, safety and adequacy of the false work or centering. All false work shall be designed and constructed to provide the necessary rigidity and to support the loads from the weight of green concrete and shuttering and incidental construction loads. False work or centering shall be founded upon a solid footing safe against undermining and protected from softening. False work which cannot be founded on satisfactory footing shall be supported on piling which shall be spaced, driven and removed in a manner approved by the Engineer-in-Charge. The Engineer-in-Charge may require the contractor to employ screw jacks or hardwood wedges to make up any settlement in the formwork either before or during the placing of concrete. Props of the upper storey shall be placed directly over those in the storey immediately below. False work shall be set to give the finished structure the required grade and camber specified on the plans.

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Formwork and Construction Joints

Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a watertight joint. The form of the permanent construction joint shall be as shown on the drawings. Temporary construction joints shall have blocks of timber at least 75 mm thick, slightly tapered to facilitate withdrawal and securely fixed to the face of the stopping off board. The area of the key or keys so formed shall be at least 30% the area of the member. The blocks shall be kept back at least 50 mm from the exposed face of the concrete. Where reinforcement passes through the face of a construction joint the stopping off board shall be drilled so that the bars can pass through, or the board shall be made in sections which a half round indentation in the joint faces for each bar so that when laced, the board is a neat and accurate fit and no grout leaks from the concrete through the bar holes or joints.

Removal of Forms and False work

In the determination of the time for the removal of forms, false work and housing, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the settings of the concrete and the materials used in the mix. MS shuttering/formwork and scaffolding should be of standard reputed make to ensure better quality of concrete finish. Forms shall be removed in such a manner as not to injure the concrete and no formwork shall be removed before the concrete has sufficiently set and hardened. The minimum periods which shall elapse between the placing and compacting of normal Portland cement concrete for the various parts of the structures are given in the following table, but compliance with these requirements shall not relieve the contractor of the obligation to delay the removal of the forms if the concrete has not set sufficiently hard.

Forms shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subject at the time of removal of formwork. In normal circumstance, generally where the temperatures are above 20°C and where ordinary Portland cement is used, form may generally be removed after the expiry of the following periods, according to the Clause 10.3, IS: 456-2000.

Table	Removal of	Walls columns and vertical fac-	24 to 48 hours as
the Forms	a.	es of all structural members	may be decided by
			the engineer-in-
			charge
b.		Slabs (Props left under)	3 days
c.		Beam soffit (props left under)	7 days
d.		Removal of props under slabs	7 days
		1. Spanning up to 4.5m	14 days
		2. Spanning above 4.5 m	
e.		Removal of props under beams	14 days
		and arches	21 days
		1. Spanning up to 4.5m	
		2. Spanning above 4.5 m	

Where sulphate resistant cement is used, manufacturer's instructions are to be followed. The Engineer-in-Charge may modify these requirements taking into account the type of cement and method of compaction used, and contractor shall obtain the Engineer-in-Charge's written approval for any decrease in time of stripping of the formwork given above. The contractor shall notify the Engineer-in-Charge when he proposes to strike of any formwork and no formwork shall be struck except in the presence of the Engineer-in-Charge or his representative

Reuse of Forms

Only mild steel formwork of best quality as per approved vendor list given by Engineer-in-Charge shall be used for concreting purpose. These shuttering shall not be reused unless it is properly scraped cleaned and repaired, so that it gives a plane, even, fair and dense concrete surface.

Cleaning and treatment of Forms

All forms shall be thoroughly cleaned of old concrete, wood shavings, sawdust, dirt and dust sticking to them before these is fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. should be scrupulously removed from the interior of the forms before concrete is poured. Wire brushes, brooms, compressed air jet and/or water jet etc. shall be kept handy for cleaning, if directed by the Engineer-In-Charge. Before formwork is placed in position, the form surface that will be in contact with concrete shall be treated with approved non-staining oil or composition, which is insoluble in water and not injurious to concrete. Care shall

be taken that the oil or composition does not come in contact with reinforcing steel or stain the concrete surface. Burnt oil shall not be allowed to be used especially where the concrete surface will require finishing and/or plaster.

Materials for Concrete

Water

Water used for cement concrete mortar, plaster, grout, curing or washing of sand shall be clear and free from injurious amount of Oil, Acid, Alkali, Organic matter or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for mixing and curing concrete. In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time specified in the IS: 456 Code of Practice for Plain and Reinforced concrete. The Engineer-in-Charge may require the contractor to get the water tested from an approved laboratory at his own expense and in case the water contains any salts for an excess of acid, alkali, any injurious substances etc., the Engineer-in-Charge may refuse its use. And the contractor shall be required to arrange suitable water at his own cost.

Aggregate

General

Coarse and Fine Aggregates for concrete shall conform in all respect to PWD Specification / IS: 383 Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. Aggregates shall be obtained from a source known to produce satisfactory material for concrete. Aggregates shall consist of naturally occurring sand and gravel or stone, crushed or uncrushed or a combination thereof. They shall be chemically inert, hard strong, dense, durable, clean and free from veins and adherent coatings and of limited porosity. Flaky and elongated pieces shall not be used. Whenever required by the Engineer-in-Charge the aggregates shall be washed by the Contractor before use in the work. The source of aggregates shall be approved by the Engineer-in-Charge and shall not be changed during the course of the

job without his approval. Rejected aggregates shall be promptly removed from the work site by the contractor at his own expense.

Deleterious Materials

Aggregates shall not contain any harmful material, such as iron pyrites, coal, mica, shale or similar laminated materials, clay, alkali, soft fragments, sea shells, organic impurities etc, in such quantities as to affect the strength or durability of the concrete and in addition to the above, for reinforced concrete, any material which might cause corrosion of the reinforcement. Aggregates which are chemically reactive with the alkalis of cement shall not be used. The maximum quantities of deleterious materials in the aggregate, shall be in accordance with IS: 2386 (Part II). Methods of Test for Aggregates for Concrete, shall not exceed the limit given in Table I of IS: 383. The sum of the percentages of all deleterious materials shall not exceed five. Deleterious materials also include material passing 75 micron IS sieve.

Coarse Aggregates

Coarse aggregate is aggregate most of which is retained on 4.75 mm IS: sieve. Coarse aggregate for concrete shall conform to IS: 383. These may be obtained from crushed or uncrushed gravel or stone and shall be clean and free from elongated, Flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter. Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits.

Table : Grading of Coarse Aggregates									
Sieve size (mm)			Percentage Passing For Single Sized Aggregate of Normal Size			Percentage Passing for Graded Aggregate of Normal Size			
40mm	20mm	16mm	12.5m	10mm	40mm	20mm	16mm	12.5m	
			m					m	
63	100	-	-	-	100	-	-	-	
40	85-100	100	-	-	95-100	100	-	-	
20	0-20	85-100	100	-	30-70	95-100	100	-	
16	-	-	85-100	100	-	-	90-100	-	
12.5	-	-	-	85-100	100	-	-	90-	

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The Engineer-in-Charge may allow graded aggregates to be used provided they satisfy the requirements and Table IV of IS: 383.

Fine Aggregates

Fine aggregates is aggregate most of which passes 4.75 mm IS sieve but not more than 10% passes through 150 micron IS Sieve. These shall comply with the requirements of grading zones I, II and III as given in Table III of IS:383. Fine aggregate conforming to grading zone IV shall not be normally used in reinforced concrete unless tests have been made by the contractor to ascertain the suitability of the proposed mix proportions and approved by the Engineer-in-Charge.

As	Table	:	Grading	Grading	Grading	Grading	per IS:
is	Grading of		Zone-I	Zone-II	Zone-III	Zone-IV	383 Table
	Aggregates						given be-
	IS: Sieve						low:
	Designa-						
	tion						
	10 mm	100	100	100	100		Note: To
	4.75 mm	90-100	90-100	90-100	95-100		the sand
use	2.36 mm	60-95	75-100	85-100	95-100		falling in
	1.18 mm	30-70	5-90	75-100	90-100		Zone -IV,
	600 mi-	15-34	35-59	60-79	80-100		383 shall
	crons						followed.
IS:	300 mi-	5-20	8-30	12-40	15-50		ne aggre-
	crons						
be	150 mi-	0-10	0-10	0-10	0-15		
Fi-	crons						

gates shall consist of natural sand resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies, or crushed stone sand or crushed gravel sand.

Sampling and Testing

Sampling and testing shall be carried out by the contractor, at the contractor's expense, in accordance with:

IS: 516 Method of test for strength of concrete

IS: 2386 Methods of test for aggregates for concrete

Storage of Aggregates

The contractor shall at all times maintain at the site of work such quantities of aggregates as are considered by the Engineer-in-Charge to be sufficient to ensure continuity of work.

Each type and grade of aggregate shall be stored separately on hard firm ground having sufficient slope to provide adequate drainage to rain water.

Any aggregate delivered to site in a wet condition or becoming wet at site due to rain shall be kept in storage for at least 24 hours to obtain adequate drainage, before it is used for concreting, or the water content of mix must be suitably adjusted as directed by Engineer-in-Charge.

Cement

General

The cement used shall be ordinary Portland cement conforming to IS: 8112 or as specified in the particular specifications/drawings or as directed by the Engineer-in-charge.

Storage on the site

The cement shall be stored in a suitable weatherproof building and in such a manner as to permit easy access for proper inspection and counting. The cement shall be stored in such a manner as to prevent deterioration. Cement of different types and brands shall be kept in separate stacks and marked accordingly. Cement older than two months shall not be used on site.

All cement stored on the site shall be arranged in batches, and used in the same order as received from the manufacturer. A cement register shall be maintained at site in which all entries shall be completed day to day, showing the quantities received date of receipt, source of receipt, type of cement etc, and also the daily cement consumption on site. This register shall be accessible to the Engineer-in-charge for his certification.

Rejection of Cement

The Engineer-in-charge may reject any cement as a result of any tests, thereof, notwithstanding the manufacturer's certificate. He may also reject cement, which has deteriorated owing to inadequate protection during storage from moisture or due to intrusion of foreign matter or other causes. Any such cement which is considered

defective by the Engineer-in-Charge shall not be used, and shall be promptly removed from the site of the work by the contractor at his own expense.

Other Materials

All materials including admixtures, joint filters and joint sealants not fully specified herein and which may be used in the work shall be of quality approved by the Engineer-in-Charge and he shall have the right to determine whether all or any of the materials offered or delivered for use in the works are suitable for the purpose. Contractor shall give the samples of materials to the Engineer-in-Charge and shall get them approved before procurement and use.

Reinforcement

All reinforcement shall be clean and free from pitting, loose mill scales, dust and coats of paints, oil or other coating which may destroy or reduce the bond.

Welded Joints

Welding of joints in reinforcement for bars of 28 mm dia and below shall not be allowed. However, in case of using welded joints for bars 32 mm and above the approval of the Engineer-in-Charge shall be obtained. The Engineer-in-Charge may require the Contractor, prior to the use of welded joints to have tests carried out at the contractor's expense to prove that the joints are of the full strength of the bars connected. The welding of the reinforcement shall be done in accordance with the recommendation of IS: 2751 code of practice for welding of mild steel bars for reinforced concrete construction. Special precautions are required in the welding of cold worked reinforcing bars. No extra payment for welded joints shall be made to the contractor unless specifically mentioned in the schedule of rates or bill of quantities and approved by the Engineer-in-Charge. Tack welding may be permitted by the Engineer-in-Charge under certain conditions for fixing reinforcements.

Reinforcement Splices

Laps & anchorage length of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller dia will guide the lap lengths. Laps shall be staggered as far as practicable and as directed by Engineer-in-Charge and not more than 50% of the bars shall be lapped at a particular section. Mechanical connections, for splicing reinforcement bars in congested locations may be used by the contractor, only if approved by the

Engineer-in-Charge. Reinforcement bars shall not be lapped unless the length required exceeds the maximum available lengths of the bars at site. Unless otherwise specified the splices shall be wired contact lap splices as per the relevant standards. No splicing of vertical bars shall be allowed except at specified or approved horizontal construction joints. Splices in horizontal bars shall be lapped with at least one continuous bar between adjacent splices. The minimum spacing of splices in anyone run of bar shall be 6.0 m with splices in adjacent bars offset at least 3.0 m where walls or slab contain two layers of reinforcement, splices in opposite layer shall be offset by at least 1.50m.

Fabrication and placement

Bars shall be pre fabricated accurately to dimensions, forms and shapes, bending procedure shall be approved by the Engineer-In-Charge. Placing and typing of reinforcement shall conform to IS: 2502-1963 Code of practice for bending and fixing of bars for concrete reinforcement. Bar bending schedules for the reinforced concrete works shown on the drawings shall be prepared by the contractors and furnished to the Engineer-in-Charge at least two weeks before the commencement of bending. Dimensions shown as furnished by the collector's shall be his responsibility and approval of the schedule shall not constitute the approval of the dimensions thereon.

Field Control

The contractor shall appoint a qualified Engineer experienced in reinforcement cutting, bending and placing the same correctly, binding and cleaning before pouring the concrete. The reinforcement shall be continuously kept in correct position during connections.

Steel Reinforcement

The reinforcement shall be High Yield Strength Deformed (HYSD) bars or TMT bars of Grade Fe-500 conforming to IS: 1786-1985 shall be used unless otherwise specified.

Placement of reinforcement should be as per IS: 456 Clause 11.3.

Approved Manufacturers: TISCO, SAIL, Rashtriya Ispat Nigam

Structural Steel

Structural steel shall conform to IS: 226 and IS: 2062.

Electrodes for welding shall conform to IS: 814 or IS: 815 or equivalent.

All bolts and nuts shall conform to IS: 1367. Stainless steel nuts and bolts shall be of SS 307 type. All materials shall be of new and unused stocks. Manufacturer's test certificate shall be made available to the Engineer-in-charge when called for.

Storage

The steel reinforcement and structural steel shall be stored in steel yard in such a way as to prevent deterioration and corrosion, preferably at least 150 mm above ground by supporting on wooden or concrete sleepers at contractor's expenses.

Proportioning of Concrete

The determination of the water-cement ratio and proportions of the aggregates to obtain the required strength shall be made from preliminary tests by designing the concrete mix as per provisions laid down in IS: 456-2000 & IS: 10262 or its latest revision. Design mix shall be admissible only if contractor is able to manage the quality control of design mix e.g. weighbridge, proper water measuring device etc. and designing the concrete mix as and when source of any of the constituent of concrete is changed. If contractor fails to comply with the requirements of design mix concrete, he shall have to follow the nominal mix as tabulated below

Table- Recommended Cement Ratio (As per IS: 456-2000) Grade of Con- crete	Recom- Water- Concrete	Nominal Mix of Concrete	Quantity of Wa- ter per 50 Kg. of cement (Max)
M 5		1:5:10	60 litres
M 7.5		1:4:8	45 litres
M 10		1:3:6	34 litres
M 15		1:2:4	32 litres
M 20		1:1.5:3	30 litres
M-25		1:1:2	26 litres

Cube tests shall be carried out by the contractor on the trial mixes before the actual concreting operation starts. Based on the strength of the concrete mix sanction for its use has to be obtained from Engineer-in-charge.

If during the execution of the works it is found necessary to revise the mix because of the cube tests lower strengths than the required one due to inconsistency of quality of material or otherwise, the Engineer-in-charge shall ask for fresh trial mixes to be made by the contractor. No extra claim shall be entertained due to

such change in mix variations, as it is the contractor's responsibility to produce the concrete of the required grade. Great care shall be exercised when mixing the actual works concrete using the proportions of the selected trial mix. The final concrete mix shall have the same proportions of cement, fine and coarse aggregates and water as that of the approved selected mix. Where the weight of cement is determined by accepting the manufacturer's weight per bag, a reasonable number of bags should be weighed separately to check the next weight. Proper control of mixing water is deemed to be of paramount importance. If mixers with automatic addition of water are used water should be either measured by volume in calibrated buckets, tins or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked and certified and the Engineer-in-Charge's approval obtained. The Engineer-in-Charge may require the contractor to carry out moisture content tests in both fine and coarse aggregates. The amount of the added water shall then be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content IS: 2386 shall be referred to. No substitution in material, used on the work or alternation in the established proportions shall be made without additional tests to show that the quality and strength of concrete are satisfactory. No alternations shall be permitted .without the prior sanction of the Engineer-in-Charge.

Mixing of Concrete

The mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixing equipment shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the solid materials are in the mixing time has elapsed. The mixing time in no case shall be less than two minutes. The mixer speed shall not be less than 14 and not more than 20 revolutions per minute. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. Hand mixing of concrete shall not be permitted at all.

Grades of Concrete

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The different grades of concrete shall conform to the strength as required by IS: 456-2000. Standard deviation shall be calculated as stated in clause 14.5 of IS: 456-2000. The acceptable criteria for concrete shall be as stated in clause 15 of IS: 456-2000.

The assumed standard deviations as given in table 6 of IS: 456-2000 have to be followed. and are given hereunder :

Table : Assumed Standard Deviation	Grade of Concrete	Assumed standard Deviation N/mm ²
	M 10	2.3
	M 15	3.5
	M 20	4.6
	M 25	5.3

In order to get a quick idea of quality of concrete, the optional tests are conducted as stipulated in 14.1.1 of IS: 456-2000 and the results are analyzed according to table 5 of IS: 456-2000.

Concrete

In general design mix concrete shall be used conforming to IS: 456-2000. Nominal Mix concrete batching by volume can only be if the contractor is not able to adhere to the quality control provision of the design mix. The mix proportions for all grades of nominal mix concrete shall be provided corresponding to the values spec-

Table - Characteristics strength of Concrete Grade Designation	Compressive : Proportion of cement : fine aggregate: coarse aggregate	Specified characteristic compressive strength at 28 days (N/mm ²)	ified in Table - 4.7 be- low for respec- tive
M 15	1:2:4	15	
M 20	1:1.5:3	20	
M 25	1:1:2	25	

grades of concrete.

The maximum water-cement ratio for all concrete works shall be as specified in IS: 456-2000 and required by the Engineer-in-Charge.

To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the

same shall be made as frequently as directed by the Engineer-in-charge. The determination of moisture contents shall be according to IS: 2386 (Part III).

Controlled concrete

Controlled concrete shall be used on all concreting works except where specified Other wise. The mix proportions for all grades of concrete shall be designed to obtain strengths corresponding to the values specified in Table 1 below for respective grades of concrete.

Table -	Grade of Concrete	Specified characteristic compressive strength at 28 days [N/mm ²]
	M 15	15
	M20	20
	M25	25
	M30	30

The maximum water cement ratio for all controlled concrete works shall be as specified in IS: 456 and Preliminary tests as specified in the IS code and required by the Engineer shall be carried out, sufficiently ahead of the actual commencement of the work with different grades of concrete, made from representative sample of aggregates and cement expected to be used on the job to ascertain the ratios by weight of cement, of total quantity of fine and coarse aggregates and the water cement ration required to produce a concrete of specified strength and desired workability The minimum cement content for each grade of concrete shall be as per Table-2 below. If the requirement of cement is found to be more than that specified below then such excess quantities of cement shall be used and for which no extra payment shall be made.

Table -

Minimum Cement Content In Concrete Grade of Concrete	Minimum cement content as per IS: 456 in kg./cu.m of finished Concrete
M 15	310
M20	360
M25	410
M30	500

At least 4 (four) trial batches are to be made and 7 (seven) test cubes taken for each batch noting the slump on each mix. These cubes shall then be properly cured and two cubes for each mix shall be tested in a testing laboratory approved by the

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Engineer at 7 (seven) days and others at 28 (twenty eight) days for obtaining the ultimate compressive strength. The test reports shall be submitted to the Engineer. The cost of mix design and testing shall be borne by the contractor. On the basis of the preliminary test reports for trial mix, a proportion of mix by weight and water cement ration will be approved by the Engineer, which shall be expected to give the required strength, consistency and workability and the proportions so decided for different grades of concrete shall be adhered to, during all concreting operations. If however, at any time the Engineer feels that the quality of material being used has been changed from those used for preliminary mix design, the contractor shall have to run similar trial mixes to ascertain the mix proportions and consistency. The mix once approved must not be varied without prior approval of the Engineer. However, should the contractor anticipate any change in the quality of future supply of materials than that used for preliminary mix design, he shall inform the same to engineer and bring fresh samples sufficiently ahead to carry out fresh trial mixes. The Engineer shall have access to all places and laboratory where design mix is prepared. Design mix will indicate by means of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed. In designing the mix proportions of concrete, the quantity of both cement, and aggregate and water shall be determined by weight. All measuring equipment shall be maintained in clean and serviceable condition and their accuracy periodical checked. To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the same shall be made as frequently as directed by the Engineer. The determination of moisture contents shall be according to IS: 2386 (Part III).

Strength Requirements

Where ordinary Pozzolona Portland cement conforming to IS: 269 is used the compressive strength requirements for various grades of concrete shall be as shown in Table -2 of IS: 456 -2000 where rapid hardening Portland cement is used the 28 days compressive strength requirements specified in Table-2 shall be met in 7 days. The strength requirements specified in Table-2 as previously given shall apply to both controlled concrete and ordinary concrete. Other requirements of concrete

strength as may be desired by the Engineer-in-Charge shall be in accordance with India Standard IS: 456-2000. The acceptance of strength of concrete shall be as per clause 14 “Sampling and Strength Test of Concrete” and clause. 15 “Acceptance Criteria” of IS: 456-2000 subject to stipulations and/or modifications stated elsewhere in this specification. if any. Concrete work found unsuitable for acceptance shall have to be dismantled and replaced to the satisfaction of the Engineer-in-charge by the contractor free of cost to the Department. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. washed in the dismantled portion shall be made. In the course of dismantling if any damage is done to the embedded items or adjacent structures, the same shall also be made good free of charge by the contractor to the satisfaction of the Engineer-in-charge. If the water quantity has to be increased in special cases, cement also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment for the additional cement shall be made.

Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer-in-Charge, alternatively the Compacting Factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests. The limits of consistency for structures are as specified in Table 4.8 below:

Table : Limits of Consistency (as per IS: 456) Placing Conditions	Degree of Workability	Values of Workability
Concreting of shallow sections with vibration	Very low	20.1 0 seconds, vee-bee time or 0.75.-0.60 compacting factor
Concreting of lightly reinforced sections	Low	10-05 seconds, vee-bee time or 0.80 - 0.85

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with vibration

* For smaller aggregate the values shall be lower.

Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour the contractor shall obtain the approval of the Engineer-in-Charge or his representative in a "Pour Card" maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability, quantity of water per unit of cement, number of test cubes to be taken, finishing to be done, any admixture to be added, etc.

Transportation and Pouring

The concrete mixer shall be as close to the place of concreting as possible but not as close as to produce vibration and disturbance to the shuttering and reinforcements. It shall be located at such a position that time lapse for transportation of unloaded concrete mix from the mixer to the place of deposition of concrete is minimum.

When there is a difference in level between the unloading platforms of concrete from the mixer to the actual place of deposition of concrete, the concrete shall be transported manually as by means of builders' hoist/crane or concrete pump to the actual level of concreting, depending on requirement as approved by Engineer-in-charge.

Chutes for transporting the concrete shall not normally be used. The Engineer-in-Charge's written permission shall be taken for transporting by means of chutes. If use of chutes is permitted then the concrete shall be again thoroughly mixed by using spades manually before placing the concrete in the moulds/shuttering to avoid segregation of concrete. It shall be ensured that initial setting of the concrete shall not take place and the mix of the concrete is as good as that of freshly poured concrete delivered directly into the moulds/shuttering. It shall be ensured that the drop of concrete is not from an excessive height and that the vibration and deposition of concrete are simultaneously carried out. Before placing concrete, all equipment for mixing and transporting the concrete shall be cleaned and all debris shall be removed from the place to be occupied by the concrete. All form and soil surface shall be finished to desired levels and shall be thoroughly wetted immediately

prior to placing of concrete. No concrete shall be placed until the Engineer-in-Charge has approved the excavation formwork and the reinforcement. The competent formwork maker and steel fixer shall be in attendance during concreting operation. The Pour card shall be signed by the contractor, designer and the representative of the consultants indicating the checking of the reinforcement, forms, and the sizes of the member to be concreted. Concrete shall be handled from the place of mixing to the place of final deposit as rapidly as practicable by methods, which shall prevent the segregation or loss of any of the ingredients. If segregation does occur during transport, the concrete shall be remixed before being placed. The concrete shall be placed and compacted before setting commences and shall not be subsequently disturbed. To ensure bond and water tightness between old concrete surface and the concrete to be placed PVC water stops of approved make and size 150 mm wide, 10 mm thick should be used. The bonding of old and new concrete shall be done by applying cement slurry after thoroughly watering the old concrete surface and removing all loose particles.

In specified cases, with approval of Engineer-in-charge the surface shall be cleaned and roughened by initial green cut by wire brushes or chipping. The initial green cutting may be done after 6 hours of placing concrete in order to facilitate the work. The old concrete walls/members shall be given a shear of 50 x 65 mm deep. This key shall also be thoroughly cleaned with wire brush in green stage before next lift pouring to avoid percolation of works.

Special methods of Concreting

If the contractor proposes to use the special methods of concreting not included in this specification, such as pumping concrete or using vacuum moulds he shall obtain the Engineer's approval before commencing work and comply with any subsequent specifications made by the Engineer for this special methods of concreting. Contractor is advised to use modern techniques in adapting methods of laying/finishing concrete in raft/wall etc., e.g. in raft, use of any other acceptable and proven method will be welcomed. The contractor may elaborate same on while quoting the offer. No extra payment shall be entertained for the approval of concreting by the special methods.

Placing of concrete in slabs and beams

Concrete in slabs shall be placed in one continuous operation for each span unless otherwise directed. Longitudinal construction joints, if required by reason of the width to be placed shall be located as shown on the drawings or as directed by the Engineer-in-Charge. Concrete in the stem and slab of T -beam shall be placed in one continuous operation and shall be deposited uniformly for the full length of the beam and brought up evenly in horizontal layers. Where the size of the member is such that it cannot be made in one pour, transverse vertical construction joints shall preferably be located within the area of contra flexure. For continuous spans, where required by design considerations the concrete placing sequence shall be approved by the Engineer-in-Charge.

Concreting floors

Concreting in floor shall be done in a chess board pattern, allowing sufficient time to elapse before the adjacent band is cast. The panel size is restricted to 7.5m in reinforced concrete slab. Concreting shall not be started unless the electrical conduits or any other piping Puddle Collars wherever required or laid by the concerned agency. The civil contractor shall afford all the facilities and maintain coordination of work with other agencies engaged in electrical and such other works as directed by the Engineer-in-Charge. Where concrete is placed on soil it shall be placed only on firm undisturbed ground. Any concrete that is placed on a well compacted fill shall have the prior approval of the Engineer-in-Charge. Concrete shall not be placed in standing water, on sub-grade or in foundation Excavation.

Compaction

Concrete during and immediately after depositing shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

- a. The vibration shall be internal unless special authorization of other methods is given by the Engineer-in-charge or as provided herein.

- b. Vibrators shall be of type and design approved by the Engineer-in-charge. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.
- c. The intensity of vibration shall be such as to visibly affect a mass of concrete of 25 mm slump over a radius of at least 0.5m
- d. The contractor shall provide a sufficiently number of vibrators to properly compact each batch immediately after it is placed in the forms.
- e. Vibrators shall be manipulated so as to have thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted into and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibration shall be at points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective.

- a. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in forms over distances so great as to cause segregation and vibrators shall not be used to transport concrete in the forms.
- b. Vibration shall be supplemented by Roding/spading as necessary to ensure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators. The whole process starting from the mixing of concrete to the placing and compaction shall not take more than 20 minutes and the process shall be completed before the initial setting takes place.

Curing

Curing shall be accomplished in accordance with IS: 456-2000 by keeping the concrete covered with a layer of sacking canvas, hessian or similar absorbent materials

and kept constantly wet for at least ten days in continuation from the date of placing of concrete unless otherwise specified. The approval of the Engineer-in-Charge shall be obtained for the method of curing the contractor proposes to use on the work. In very hot weather precautions shall be taken to see that temperature of wet concrete does not exceed 38°C while placing. Heavy loads shall not be placed on or moved across over the floor slabs until curing is complete. Care shall be taken to prevent floor surface from being marred during curing period. Freshly laid concrete form work shall not be jarred. Concrete placed in trenches or Excavation shall be protected from falling earth during and after placing.

Consistency

The consistency of concrete shall be frequently checked by means of a slump test performed as per the relevant Indian Standard by the Engineer-in-Charge. The maximum and minimum slump for each class of concrete shall be as directed by the Engineer-in-Charge, and any concrete as represented by the slump test which fails to comply with these directions shall be removed from the site and disposal off at the contractors cost.

Finishing Concrete

On striking the formwork, all blowholes and honeycombing observed shall be brought to the notice of Engineer-in-Charge. The Engineer-in-Charge may, at his discretion allow such honeycombing or blowholes to be rectified by necessary chip-pings and packing or grouting with concrete or cement mortar. If mortar is used, it shall be 1:2 mix or as specified by Engineer-in-Charge. However, if honey combing or blowholes are of such extent as being undesirable, the Engineer-in-Charge may reject the work totally and his decision shall be binding. No extra payment shall be made for rectifying these defects. All burrs and uneven faces shall be rubbed smooth with the help of carborundum stone. The surface of non-shuttered faces shall be smoothened with a wooden float to give a finish equal to that of the rubbed down shuttered faces. Concealed concrete faces shall be Left as from the shuttering except that honeycombed surface shall be made good as detailed above. The top faces of slabs not intended to be surfaced shall be leveled and floated to a

smooth finish at the levels or falls shown on the drawings or elsewhere. The floating shall not be executed to the extent of bringing excess fine material to the surface.

The top faces of slabs intended to be covered with screed, granolithic or similar faces shall be left with a rough finish.

Work in Extreme Weather

During hot weather (atmospheric temperature above 40 degree centigrade) or cold weather (atmospheric temperature at 5 degree centigrade and below) the concreting shall be done as per the procedure and precautions set out in IS: 7861 (Part I and II).

Dependence shall not be placed on salt or other chemicals for the prevention of freezing. Calcium chloride shall not be used as an accelerator except with the approval of the Engineer-in-Charge. Recommendation given in relevant clauses of IS: 456 shall be strictly adhered to.

Loading of the Structures

No concrete structures shall be loaded until the concrete is at least 28 days old and only then with the approval of the Engineer-in-Charge and subject to such conditions as he may lay down.

Testing and Acceptance Criteria of Concrete

The sampling of concrete making the test specimens, curing and testing procedures etc. shall be in accordance with IS: 1199, IS: 3085 and IS: 516, the size of specimen being 15 cm cubes. Normally only compression tests shall be performed in accordance with IS: 516. For each grade of concrete and for each 8 hours of work or portion thereof the following samples shall be taken. At least six specimens shall be taken from the first 15.0 m³ or part thereof and three of these shall be tested at 7 days and the remaining at 28 days. Four additional specimens shall be taken from each additional 15.0 m³ of concrete or portion thereof of which 2 specimens shall be tested at 7 days and the remaining at 28 days. To control the consistency of concrete from every mixing plant slump tests, and/or compacting factor tests in accordance with IS: 1199 shall be carried out by the contractor every two hours or

as directed by the Engineer-in-Charge. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456-2000. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specifications by the contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement embedded fixtures etc. shall be paid. In the course of dismantling if any damage is done to, the embedded items or adjacent structures the same shall be made good free of charge by the contractor to the satisfaction of the Engineer-in-Charge.

Load Test of Structures

The Engineer-in-Charge may instruct for a load test to be carried out on any structure if in his opinion such a test is deemed necessary for any of the following reasons. The works site made concrete test-cube failing to attain the specified strength, as per the criteria laid down in IS: 456-2000. Suspected overloading during construction of the structure under review Shuttering being prematurely removed and not as per the specification The concrete is being improperly cured. Visible deficiencies of the concrete If the results of the load test be unsatisfactory, the Engineer-in-Charge may instruct the Contractor to demolish and reconstruct the structure or part thereof at the contractor's cost. The load test of structures shall be carried out as per the clause 16.5 of IS: 456-2000.

Special methods of concreting

The contractor should propose to use special methods of concreting not included in the specifications, such as pumping concrete or using vacuum moulds, he shall obtain the Engineer-in-Charge's approval before commencing work and comply with any subsequent specification made by the Engineer-in-Charge for this special method of concreting. Contractor is advised to use modern techniques in adopting methods of laying/finishing concrete in raft/walls etc. e.g. in raft use of any other acceptable and proven method will be welcomed. The contractor may elaborate same on while quoting the offer.

Codes and Standards

All applicable standards, specifications, etc. and codes of practice shall generally be the latest editions, including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the contractor. All work shall be carried out as per the stipulations contained in various sections of these specifications and the latest Indian Standards, Acts, Codes and best practices. In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian Standard, Codes, etc. the requirements of stipulations contained in various sections of these specifications, shall prevail over that of Indian Standards, Codes, etc.

Some of the applicable Indian Standard Codes, etc. are referred to here below. IS:73	Specification for paving bitumen
IS:2060	Specification for structural steel
IS-8112	Specification for ordinary Portland cement 43 grade.
IS:280	Specification for mild steel wire for general engineering purposes
IS:383	Specification for coarse and fine aggregates from natural sources for concrete
IS:432 (Part I & II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS:455	Specification for Portland Slag Cement
IS:456	Code of practice for plain and reinforced concrete
IS:457	Code of Practice for general construction of plain & reinforced concrete for dams and other massive structure.
IS:516	Method of test for strength of Concrete
IS:650	Specification for standard sand for testing of cement
IS:702	Specification for industrial bitumen
IS:816	Code of practice for use of metal as welding for general construction in mild steel
IS:1199	Methods of sampling and analysis of concrete

IS:1200 (Part II, V, VIII, XVIII, SVIII)	Method of measurement of building and civil engineering works, water proofing and damp proofing
IS:1367	Technical supply conditions for threaded steel fasteners
IS:1489	Specification for Portland pozzolona cement (Part I) Fly ash based & (Part II) Calcite clay based
IS:1566	Specification for Hard drawn steel wire fabric for concrete reinforcement
IS:1609	Code of practice for laying damp proof treatment. Using bitumen felts.
IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS:1791	General requirements for batch type concrete mixer.
IS: 1838	Specification for performed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type)
IS:2204	Code of practice for construction of reinforced concrete shell roof
IS:2210	Criteria for the design of reinforced concrete shell structures and folded plate
IS:2386 (Part 1 to VIII)	Methods for test of aggregates for concrete
IS:2438	Specification for roller pan mixer
IS:2502	Code of practice of bending and fixing of bars for concrete reinforcement
IS:2505	General requirements for concrete vibrators, immersion type
IS:2506	General requirements for concrete vibrators, screen board type
IS:2514	Specification for concrete vibrating tables
IS:2571	Code of practice for laying in situ cement concrete flooring
IS:2645	Specification for integral cement water proofing compounds
IS:2722	Specification for portable swing weigh batchers for concrete (single and double bucket type)

IS:2750	Specification for steel scaffoldings
IS:2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction
IS:3025	Methods of sampling and test waste water
IS:3067	Code of practice for general design details and preparatory work for damp proofing & water proofing of buildings
IS:3150	Specification for hexagonal wire netting for general purposes
IS:3366	Specification for pan vibrators
IS:3370 (Part I & II)	Code of practice for concrete structures for the storage of liquids
IS:3384	Specification for bitumen primer for use in water proofing & damp proofing
IS:3414	Code of practice for design and installation of joints in buildings
IS:3550	Methods of test for routine control for water used in industry
IS:3558	Code of practice for use in immersion vibrators for consolidating concrete
IS:3696 (Part I & II)	Safety code for scaffolds and ladders
IS:4014 (Part I & II)	Code of practice for steel tubular scaffolding
IS:4031	Methods for physical tests for hydraulic cement
IS:4130	Safety code for demolition of buildings.
IS:4326	Code of practice for earthquake resistant design and construction of buildings
IS:4461	Code of practice for joints in surface hydroelectric power stations
IS:4656	Specification for form vibrators for concrete
IS:4925	Specification for batching and mixing plant
IS:4990	Specification for plywood for concrete shuttering work
IS:4995 (Part I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials

IS:5121	Safety code for piling and other deep foundations
IS:5256	Code of practice for sealing joints in concrete lining on canals
IS:5525	Recommendations for detailing of reinforcement in reinforced concrete work
IS:5624	Specification for foundation bolts
IS:6461	Glossary of terms relating to cement concrete
IS:6494	Code of practice for water proofing of underground water reservoirs and swimming pools
IS:6509	Code of practice for installation of joints in concrete payments
IS:7193	Specification for glass fiber base coal tar pitch and bitumen felts
IS:7293	Safety code for working with construction machinery
IS:7861 (Part I & II)	Code of practice for extreme weather concreting
IS:9012	Recommended practice for shuttering
IS:9103	Specification for admixtures for concrete
IS:9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS:9595	Recommendations for metal-arc welding of carbon and carbon manganese steels
IS:10262	Recommended guidelines for concrete mix design
IS:11384	Code of practice for composite construction in structural steel and concrete
IS:12118	Specification for two parts polysulphide.
IS:122000	Code of practice for provision of water slops at transverse contraction joints in masonry and concrete dams
IS:12269	53 grade ordinary Portland cement
IS:12600	Portland cement, low heat
IS:23	Handbook of concrete mixes
IS:24	Explanatory Handbook on IS:456-1978

Item. No. providing and fixing in position steel bar reinforcement
(Corrosion Resistant Still) ----- Etc complete

The specification provided in the subwork for Sewerage collection system shall be referred

The specification contained in standard specification volume -II

Published by P.W and housing department, Govt, of Maharashtra chapter Bd-F-17
And F-18 /306 shall apply.

Design details and bar bending schedule will be submitted by Contractor at his cost during course of execution and accordingly reinforcement shall be provided.

Actual reinforcement placed shall be measured at theoretical standard

Weights, calculated from total length of reinforcement the density of reinforcement shall be assumed as 7850 kg /cum.

All reinforcement shall be accurately placed in position with spacing and covers as directed and tied with binding wires /of 1.63 mm or 1.22 mm dia. Spacing of bars shall be maintained by means of stays, blocks, ties, spacers or other approved supports at sufficiently close intervals so that bars will sag between neither supports nor set displaced during vibrating or vibrating concrete or by any others

Operation . Representative samples of reinforcement in each lot shall be got tested in the laboratory of Government Polytechnic, Government Engineering College for various tests as per recent circular of M.J.P. or I.S. at the cost of the contractor. M.S. reinforcement not conforming to relevant I.S.I. shall be rejected and the same shall be removed from the site of work immediately without any extra claims. The test certificates of reinforcement from Govt. Polytechnic / Govt. College of Engineering shall be submitted by the contractor during each lot.

The item includes cleaning, cutting; bending and binding with binding wire and placing reinforcement in position and maintaining it clear and in position till the concrete is laid. The reinforcement shall be C.R.Steel only.

PROVIDING FUSION BONDED EPOXY COATING

(Sub-work No, Item No.),)

Providing fusion bonded epoxy coating to reinforcement bars as per ASTM-755 specification for a thickness of 175 (+50) microns including extra cost on account of careful handling, extra cost on account of using PVC coated binding wire instead of G. I. wire, extra cost on account of touch-up material supplied by coating agency and repair work extra cost account of transportation to and fro from steel yard at - ----- to plant at Daman and Plant at Daman to work site by trailer, loading, unloading, including all taxes (Central and Local), etc. complete.

MODE OF MEASUREMENT AND PAYMENT

The item shall be measured and paid in weight per MT basis.

Item No:- Providing IInd class B.B. Masonry -----etc. complete in C.M. 1:6

This shall be done as per standard specification No. Bd-G-I & 5 on Page no. 313 & 315 respectively. This item includes brick masonry in C.M. 1:6 for Plinth, super structure and steps. Steps up to plinth level of 1m width including P.C.C. M-150 grade and 100mm. thick, below base of steps, also 20mm plastering Both faces and cement concrete flooring over the steps. The thickness of joints in brick work shall be 12mm for conventional bricks and 10 mm for I.S. type bricks. The bricks shall be used for above work including

Transportation, loading, unloading, stacking properly at the site of work at the cost of Contractor and shall be got approved by Engineer-in-charge. The representative Samples as per recent circular of M.J.P. shall be tested for various test in the laboratory of Government Engineering College at the cost of contractor.

Brick masonry

General

All bricks shall be of class designation 10 or best locally available approved by Engineer-in-Charge made of good brick earth thoroughly burnt, and shall be of deep cherry red or copper color. Bricks shall be regular in shape and their edges shall be sharp and shall emit clear ringing sound on being struck and shall be free from cracks, chips, flaws and lumps of any kind. Bricks shall not absorb water more than one sixth of their weight after one hour of soaking by immersing the water. Bricks shall have a minimum crushing strength of 105 kg/cm² (10.5 N/mm²). Bricks shall be fully soaked in clean water by submerging in a tank for a period of 12 hours immediately before use. Soaking shall be continued till air bubbling is ceased. Bricks shall be well bonded and laid in English bond unless otherwise specified. Every course shall be truly horizontal and wall shall be truly in plumb. Vertical joints of consecutive course shall not come directly over one another; vertical joints in alternate course shall come directly over one another. No damaged or broken bricks shall be used. Closers shall be of clean-cut bricks and shall be placed near the ends of walls but not at the other edge. Selected best-shaped bricks shall be used for face work. Mortar joints shall not exceed 6 mm in thickness and joints shall be fully filled with mortar. Bricks shall be laid with frogs upwards except in the top course where frogs shall be placed downward. Brickwork shall be carried out not more than 1.2m height at a time. When one part of the wall has to be delayed, stepping shall be left at an angle of 45°. Corbelling or projections where made shall not be more, than X brick projections in one course. All joints shall be raked and faces of wall cleaned at the end of each day's work. These specifications deal with all types of brickwork required for buildings, manholes, drains, retaining walls or any construction made out of bricks.

Materials

Bricks

Bricks used for the construction of brick masonry shall be hard, rectangular in shape and size and well burnt of uniform deep red, cherry or copper color and shall confirm to IS: 1077-1986. The brick shall not break when it falls down from 1.0 m height above the ground. Over burnt and the under burnt bricks will not be accepted. It should give the ringing sound when struck up with the hard material. The

bricks shall be brought from approved brick kilns. The bricks shall be free from cracks, chippings, flaws, stones or lumps of any kind. The bricks shall not show any signs of efflorescence and shall be homogeneous in texture. They shall emit a clear metallic ringing sound on being struck and shall have a minimum compressive strength of 10.5 N/mm² equivalent to 105 kg/cm². They shall not absorb more than 20% of its dry weight when soaked in cold water for 24 hours or otherwise specified in the Indian Standard Specification.

Mortar

The proportion of the cement mortar used for the masonry work shall be as specified on the various drawings for different places/types of construction, specifications for each part of the work.

For cement mortar fresh Portland cement of standard specifications shall be used. Sand shall be sharp, clean and free from organic and foreign matters. For rich mortar coarse or medium sand shall be used and for weak mortar local fine sand may be used. Materials of mortar shall be measured to have the required proportion with measuring box and first mixed dry to have a uniform color in a dean masonry platform and then mixed by adding clean water slowly and gradually to have workable consistency and mixed thoroughly by turning at least three times. Fresh mixed mortar shall be used, old and stale mortar shall not be used and mortar for an hour work only shall be mixed with water so that the mortar may be used before setting starts. Coarse sand is mixed with the required quantity of cement for the preparation of the mortar. Mortar shall be prepared in accordance with IS: 2250-1981. The sand used for the masonry mortar shall meet the requirements as specified in IS: 2116-1980. For masonry mortars, sand and cement of required proportions are mixed in small quantities in a dry state first and then water is added to make the mortar of required consistency suitable for the type of work for which it is required as directed by the Engineer-in-Charge. No left over mortar shall be used and therefore only that much quantity of mortar that can be consumed within 30 minutes shall be mixed in batches.

Sand for Brick Masonry

Table : Grading of sand for use in Masonry Mortar IS	Percentage passing by mass
Sieve Designation	
4.75 mm	100
2.36 mm	90 to 100
1.18 mm	70 to 100
600 micron	40 to 100
300 micron	5 to 70
150 micron	0 to 15

Construction

The brick masonry shall be constructed as per the Indian Standard Code of Practice for Brick Work IS: 2212-1962. The thickness of the joints shall not be thicker than those specified in Para 5.4 of the above Code of Practice. The bricks shall be thoroughly soaked in water before using them on the work for at least twelve hours and all the air bubbles shall come out during soaking process. The soaked bricks shall be stacked on wooden planks/platforms so as to avoid sticking of the earth and other materials on to the surfaces of bricks. Bricks required for construction in mud mortar or lime mortar shall not be soaked. Brickwork shall be laid in English Bond unless otherwise specified. Half bricks shall not be used except when needed to complete the bond. Each course shall be perfectly straight and horizontal. The masonry shall be true to plumb in case of vertical walls and in case of battered construction the batter or slope shall be truly maintained. The level of the courses completed shall be checked at every one meter interval or less as required. While constructing the brick work one side shall be in plumb as directed by the Engineer In Charge.

The bricks shall be laid frogs upwards. While laying the bricks they shall be thoroughly bedded and flushed in mortar and well tapped into position with wooden mallets and superfluous mortar shall be removed. No part of the structure shall be raised more than one meter above than the rest of the work. In case it is unavoidable the brickwork shall be raked back at an angle of not more than 45 degrees so as to maintain a uniform and effectual bond, but raking shall not start within 60 cms from a corner. In case of construction of buttresses, counter forts, returns they are built course by course carefully bound into the main walls. At all junctions of walls the bricks at alternate courses, shall be carried into each of the respective walls so

Contractor

No. of correction

Executive Engineer

as to thoroughly unite both the walls together. The brickwork shall not be raised more than 14 courses per day. All the beds and joints shall be normal to the pressures applied upon them Le horizontal in vertical walls, radial In arches and at right angles to the face in battered retaining walls. Vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken to ensure that all the joints are fully fitted up with mortar, well flushed up where no pointing is proposed, nearly struck as the work proceeds. The joints in faces which are plastered or painted shall be squarely raked out to a depth not less than 12 mm while the mortar is still green. The raked joints shall be well brushed to remove the loose particles and the surfaces shall be cleaned with a wire brush so as to remove any splashes of mortar sticking to the surfaces during the construction. All iron fixtures, pipes, bolts, conduits, sleeves, holdfasts etc. which are required to built into the walls shall be embedded in cement mortar or cement concrete as shown in the drawings/indicated in the specifications/directed during the execution by the Engineer in-Charge as the work proceeds and no holes be left for fixing them at a later date unless authorized by the Engineer-in-Charge.

Curing

Green work shall be protected from rain by covering the work suitably. Masonry work as it progresses shall be thoroughly kept wet by watering on all the faces for at least 10 (Ten) days in continuation after completion of the parts of the work. Proper watering cans, flexible pipes, nozzles shall be used for the purpose in case of fat lime mortar curing shall start two days after construction of masonry and shall continue for seven days. No additional payment is admissible for curing and the rates quoted are deemed to be inclusive of the cost of curing.

Scaffolding

Double scaffolding sufficiently strong so as to withstand all loads that are likely to come upon it and having two sets of vertical supports shall be provided. Where two sets of vertical supports are not possible the inner end of the horizontal supporting pole shall rest in a hole provided in a header course only. Only one header for each pole shall be left out. Such holes however shall not be permitted in pillars less one meter in width or immediately near the skew backs of arches. Such holes shall be

filled up immediately after removal of the scaffoldings. Safety Code for Scaffolds and Ladders, IS: 3696-1987 (Parts I and II) shall be followed.

Mode of Measurement :

The contract rate shall be for a unit of one cubic meter of Masonry. The concrete shall be measured for its length, breadth and depth limiting dimensions to those specified on the plan or as directed by Engineer-in-Charge. No deduction shall be made for reinforcement in concrete in RCC work. Individual dimension shall be measured in Cum. And quantities shall be worked out correct upto three places of decimal of a cubic meter.

HALF BRICK MASONRY

The half brick masonry shall be in cement mortar specified in the item but not weaker than 1:4.

Mode of measurement : Per Sq,mt.

The half brick masonry shall be reinforced by 2 No. of 6 mm dia M.S. longitudinal bars or 2 No. of hoop item strips of 25 x 1.6 mm size, at even third course properly bent and bounded in vertical joints of the brick work or to main walls as directed by the Engineer-in-charge, if continuous strip is not available, strips shall be rivet jointed with a minimum overlap of 8 cm. All the bricks shall be laid stretch wise breaking joint with the upper and lower courses. Fixtures, plugs, hold, fasts, frame down, windows shall be based into brick work while laying only and of the correct levels and positions. Holes of required size and stage shall be left in the brick work during laying for fixing pipes or service lines, passage of water etc. After the pipeline work is completed, extra hollow left around the hole shall be plugged with 1:3 cement mortar or 1:3:6 cement concrete. Hold fasts for frames of doors and windows shall be accommodated in the joints of the brick which laying. The joints in the courses where reinforcements is places shall admit of a mortar cover at least 5 mm for the brick work with 15 bricks and not more than 12 mm for conventional brick work. A set of mason's tools shall be maintained on work for each group of 3 masons or less for frequent use and checking. The ends of walls shall be bonded into the side walls where necessary.

The joints shall be raked out to depth not less than the thickness of the joints.

This item shall include :

- a) Providing and fixing mild steel reinforcement bars or hoop iron strips as mentioned above.
- b) Leaving holes for fixtures or pipes and making them good after completion of the work.
- c) Building in frames, hold fasts etc. and forming chassis and grooves.

Mode of measurement

The contract rate shall be for a unit of one Square meter and quantities shall be worked out correct upto three places of decimal of a Sqmt..

Item No. :- Providing cement Plaster.....etc complete.

This shall be done as per standard specification No.Bd-L-5 page No.368. The item shall comply with specification B.11.b subject to the additional clauses Bd.L 1.2, Bd.L 1.3, Bd.L 1.4

- i) 20mm thick cement plaster in C.M. 1:2 with water proofing (Wet well) shall be provided to innerface of vertical wall of sump (Wet well) & pump house (dry well) and screen chamber.
- ii) 20mm thick cement plaster in C.M. 1:3 shall be provided to external Face of brick work to pump house.
- iii) 12mm thick cement plaster in C.M. 1:3 shall be provided to internal Faces of brick work to pump house, external face of screen chamber, wet well and dry landings (bottom portion), waist slab ceiling and sides, roof slab ceiling etc.

All above plaster shall be done in Sulphate Resistant Cement only Number of cubes for Cement mortar shall be taken as per I.S. and recent circular of M.J.P. and shall be tested in the laboratory of Government Engineering College at the Cost of contractor. Certificate of testing shall be submitted by the contractor to the department. Cement mortar used for plastering shall be of the mix proportions and thickness as specified on the drawings or bill of quantities or particular specifications for the various different parts of the works. The materials used i.e.

cement, sand and water shall be of the same quality and of the same specifications as indicated for plain and reinforced cement concrete works according to the specifications and approved by the Engineer-in-Charge. Sand further shall meet the specifications as laid down in IS: 1542-1977 Specification for sand for plaster.

The sand for preparation of mortar for plastering shall confirm to the following gradation, shown in Table

Table
: Grading of fine aggregates *Percentage by weight passing IS Sieve*

IS Sieve Designation	Class -A	Class-B
4.75 mm	100	100
2.36 mm	90 to 100	90 to 100
1.18 mm	70 to 100	70 to 100
600 Microns	40 to 85	40 to 95
300 Microns	50 to 50	10 to 65
150 Microns	0 to 10	0 to 15

For the purpose of indicating the suitability for use, the sand is classified as Class A and Class B in accordance with the limits of grading. Class A sand shall be used generally for plastering and when they are not available, Class B sand may be used with the approval of Engineer-in-Charge.

The procurement of sand for Mortar for plastering and pointing shall confirm to be specifications given in Table. Surface that are to be applied with plaster shall be thoroughly cleaned to remove dust, dirt, loose particle, oil, soil, salts etc, that may be sticking to the surfaces. The surfaces shall be washed, clean and watered properly for 4 hours before applying plaster. For masonry all joints in the frame work that is to be plastered shall be raked out to a depth not less than the width of the joints or as directed by the Engineer-in-charge. The raking shall be done taking care not to allow any chipping of masonry. In new work the raking out shall be done while the mortar in the joints is still green. Smooth surface of concrete or plaster etc. must be suitably roughened to provide necessary bond for the plaster all dirt, soot oil paint or any other materials that might interfere with satisfactory bond shall be removed and surface wetted before plastering is started. Plaster shall not, in any case, be thinner than specified. It shall have uniform specified thickness. When smooth finishing is required the cement plastering shall be floated

over with neat cement within 15 minutes after application of the last coat of plastering. The plaster shall be protected from the sun and rain by such means as the Engineer-in-Charge may approve.

The plastered surface shall be cured for 10 (ten) days. Construction joints in plastering shall be kept at places approved by the Engineer-in-charge. When the thickness of the plaster specified is to be made up in more than one layer the second layer shall be applied only when the lower coat is still green. Wherever specified approved brands of additives like water proofing compounds, shall be added in specified quantities as recommended by the manufacturer of the compound or as directed by the Engineer-in-Charge.

Wherever scaffolds are necessary for plastering they shall be provided as specified for scaffolds under clause 3.2.2. Stage scaffolding shall be provided for ceiling plaster. To ensure even thickness and true surface, patches of plaster about 15 cm x 15 cm shall be first applied both horizontally and vertically 2.0 m apart. Plastering shall be done. From top of bottom and care shall be taken to avoid joints on continuous surface. In case any other finish like rough cast finish or dry dash finish is specified in the drawings the small shall be provided as directed by the Engineer-in-Charge. Surface which is to be plastered shall be roughened while they are still green or raked so as to give proper bond between the surface and plaster. When cement finish is specified, coat of pure Portland cement slurry 1.5 mm (1/6') thick shall be applied to the plastered surface while the second coat is still fresh. If neeru finish is specified, then the surface shall be finished as per specification for Item Bd.L-10.

All corners junctions shall be truly vertical or horizontal as the case may be and carefully finished. Rounding or chamfering of corners shall be carried out with proper templates to the required size and shapes. The work shall be tested frequently with a straight edge and plumb bob. At the end of the day the plaster shall be left cut clean to line. When the next days plastering is started, the day the plaster shall be left cut clean to line. When the next days plastering is started the edge of the old work shall be scrapped, cleaned and wetted with cement slurry. At the end of the day the plastering shall be closed on the body of the wall and not nearer than 15 cm to any corner. Curing shall be started as soon as the plaster has

hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for at least 10 days. Any defective plaster shall be cut in rectangular shape and replaced. The thickness of the cement plaster shall be 12 mm excluding cement or neeru finish.

Mode of measurement

As per NdL-1.7 on square meter basis

MATERIALS

Cement mortar shall be prepared from cement and as specified for RCC work and mixed in the proportion specified. Sand shall be screened and washed if called upon to do so. Water proofing compound of directed make in directed quantities shall be added where it is water proof plaster, scaffolding shall be prepared from sound materials and shall be provided, where ever situation demands for facility of proper working.

GAUGES

Patch of plaster 15 x 15 cm shall be put on about 3 m apart as gauges to ensure even plastering in one place.

FINISHING

In any continuous face of wall, finishing treatment of any type shall be carried out continuously and day to day breaks made to coincide with architectural breaks in order to avoid unsightly junctions. All mouldings shall be worked true to template and drawn neat, clean and level. All exposed angles, junctions and openings shall be carefully finished.

WATERING

All pointing work shall be kept damp continuously for a period of 14 days. To prevent excessive evaporation of the sunny and wind ward side of the building in hot, dry weather matting or gunny bags may be hung over on the outside of the plaster in the beginning and kept moist. If the contractor fails to water the work to the satisfaction of the Engineer-in-charge, the requisite labour, materials and equipment to water the work properly shall be engaged departmentally at the cost of the contractor. Cost all scaffolding is included in the tender rate.

SAND FACED CEMENT PLASTER

GENERAL

The item shall comply with the specification B.11 in all pertinent particulars. In addition Bd.L.1.2, Bd.L 1.3, Bd.L 1.4 and the following specifications shall also be complied with.

Base Coat : The base coat plaster shall be of cement mortar 1:4. Water proofing compound of approved make like Pudlo, Sika, Accorproof shall be added according to the maker's instruction in Bd.L 2 which a thickness of 15 mm for brick work and concrete surfaces and 20 mm for rubble stone masonry. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still plastic.

Sand Faced Treatment : The cement mortar for sand faced plaster shall have washed Kharsalia or Kasaba or similar type of approved sand with slightly larger proportion of coarse material. The proportion of cement to sand shall be 1:4. The water is added gradually to make the mixture homogeneous. The thickness of finishing coat shall not exceed 8 mm. After applications the surface should be finished with a wooden float lined with cork and tapped gently to retain a coarse surface texture. When the finishing coat has hardened the surface shall be kept moist continuously for 14 days.

Item to include relevant portion of Bd.L 1.6. It shall also include the base coat and sand face treatment of above.

Mode of Measurement and payment per Bd.L 1.7 on square meter basis

The specification lays down the requirements of applying sand faced plaster in specified thickness with cement mortar to concrete or masonry surface in specified coats. This shall conform to specification for ordinary cement plaster where ever it is not irrelevant and in addition following shall also be applicable.

Tools and accessories used in plastering work be thoroughly cleaned before plastering is done. The programming of other building operations before during and after plastering shall be according to the instructions contained in Clause 4 of IS:1661-1960 or its latest revision. The item shall be executed as per Red book

specification BdL-7 to 7.50 page No. 351)

Care shall be taken that other parts of work of adjacent work are not damaged while plastering. The base coat plaster shall be of cement mortar of specified proportion 1:4 and thickness as mentioned in the item or otherwise, it shall be of cement mortar 1:3 and thickness 15 mm to 20 mm. The base coat shall be laid in a similar manner as stipulated in. However, instead of finishing the top surface smooth keys shall be formed on the surface thoroughly combined in with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still plastic. The base coat shall be cured for suitable period as per relevant code.

Item No - Cement paint

This shall be done as per standard specification No. Bd- Page No . & Schedule 'b' & as directed by Engineer-in-charge

Material

The cement Paint of white portland cement shall be (conforming to IS 5410) of approved brand . Colour and shade and manufacture. The cement Paint shall be brought to the site of work by the contractor in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the Engineer-in-Charge

Scaffolding wherever necessary shall be provided to the entire satisfaction of the Engineer-in-Charge.

Preparation of Surface

For New Work, the surface shall be thoroughly cleaned of all mortar dropping, dirt all loose dust, algae, all cracks grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement Paint shall be applied over patches after wetting them thoroughly. Holes and sur-

face defects shall be repaired with cement plaster cured and allowed to set hard. Any grease, oil paint, shall be removed by approved methods..

Preparation of Mix

Cement Paint shall be mixed in such quantities as specified by the manufacturer as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with admixture.

The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes.. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously. The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade. For old work, the treatment shall be with one or more coats as found necessary to get a uniform

shade. . The paint shall be kept stirred and used within one hour of mixing hardened or damaged paint shall not be used. The paint shall be applied by brushes in the manner specified by the manufacturer .The number of coats shall be specified in the wording of the item. When more than one coat is to be given the subsequent coats shall be applied after the preceding coat has thoroughly hardened, inspected and approved.

Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, color wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, color wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, color wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement. The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14. The coefficient for cement Paint on RCC Jalli shall be the same as provided in Sl. No. 7 of Table 1 under para 13.23.6.4 for painting trellis for Jaffri work.

Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

Application

Base coat of water proof cement paint - All specifications in respect of base coat of water proofing cement paint shall be as described. Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its con-

sistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously. The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described

CURING

Each application of paint should be wetted at the end of the day with a fine water spray, depending on climatic conditions. Wetting shall be done only after an interval of at least 6 to 8 hours after the applications. In dry weather the painted surfaces shall be kept damp for at least two days and protected from direct sun.

MODE OF MEASUREMENT AND PAYMENT

The item includes,

- a) All materials and labour for painting.
- b) All equipment and scaffolding.
- c) Curing as per specification
- d) Non uniform colour or shade shall be rectified without any extra cost.

The item shall be measured and paid in per Sqmt basis of area painted.

Item No.:- Providing and laying white marble mosaic tiles----as directed etc complete.

This shall be done as per standard specification No. Bd-M-14 pageNo. 386. The colour and shade of tiles shall be got approved from Engineer-in-charge. The tiles shall be of approved manufactures of standard make.

Item No :- Providing and laying flooring of plain tiles etc complete

This item shall be executed as per the detailed specification and as per relevant

item described in schedule B This item shall comply as per standard specification No Bd- M-8 on Page No 383

Item No:-Providing and Laying cement concrete flooring of of 40mm. thick-----
etc complete.

This shall be done as per standard specification No. Bd-m-7 page No 383. Please refer the specification for item for Concrete.

Providing and laying cement concrete flooring 40 mm thick with cement concrete M-25 laid to proper line, level and slope in alternate days including compaction, filling joints marking lines to give appearance of tiles 30cm x 30cm or other approved design, finishing smooth (with extra cement) in approved colour as directed and curing etc. complete.

MODE OF MEASUREMENT AND PAYMENT

The item shall be measured and paid in weight per Sqm. basis.

POLISHED SHAHABAD/TANDUR/KOTAH STONE FLOORING

The specification for this item shall be same as for item No. B.M.1

1. All the stone slabs shall be square in shape. The dimensions shall be 0.60 x 0.60 m or other dimensions as specified in the special provisions or as directed by Engineer-in-Charge. Tolerance in thickness ± 3 mm
2. The exposed surface of the specified stone flags shall be machine polished to a smooth, even and true plane and the edges machine cut square and to the required shape when necessary. Samples shall be got approved by the Engineer-in-Charge who will keep them in his office for reference.
3. The thickness of joints shall not exceed 1.5 mm
4. Joints shall be grouted with neat cement slurry
5. When the bedding and joints of the flooring have completely set, the surface shall be machine polished to give a smooth, even and true plane to the floor and thoroughly cleaned.

Mode of measurement : Per sq meter

28 GLAZED TILES FOR SKIRTING AND DADO

Plastering : Cement plaster of about 12 mm for brick walls and 20 mm for stone masonry walls shall be applied to the part of the wall where dado or skirting is to be fixed as per specification No. B.11. The proportion of mortar shall be as mentioned in the item.

Fixing tiles : Dado or skirting work shall be done only after fixing tiles on the floor. The white glazed tiles shall be soaked in water for at least 2 hours before being used for skirting or dado work. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff. The back of tiles shall be covered with a thin layer of neat cement plaster and the tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from the bottom of wall upwards without any hollows in the bed or joints. Each tile shall be fixed as close as possible to the one adjoining. The tiles shall be joined with white cement slurry. Any difference in the thickness of tiles shall be evened out in cushioning mortar so that all tile faces are in the vertical plane. The joints between the tiles shall not exceed 1.5 mm in width and they shall be uniform between the tiles in dado work, care shall be taken to break joints vertically. After fixing the dado, skirting etc. they shall be kept continuously wet for 14 days. If doors, windows or other openings are located within the dado area, the sills, jambs, angles etc. shall be provided with white glazed tiles and appropriate specials according to the foregoing specification and such tiled area shall be measured net along with the dado.

Cleaning : After the tiles have been fixed the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing the dado or skirting work shall be washed thoroughly clean.

Item to include : The rate shall include all labour, materials, tools and equipment required for the following operations to carry out the item as specified above.

- Plastering
- Fixing the tiles including all angles, etc., after applying neat cement paste
- Jointing the tiles with white cement slurry
- Curing

- Cleaning the dado and skirting.

Mode of measurement and payment : Same as for item No. Bd.M-9.

Item No. :-Providing and fixing steel window of various sizes as per detailed drawings----etc. complete.

This item shall comply with the specification No.Bd-T-53 on page No. 509 and Relevant item of Schedule 'B'.

Item No.:- Providing and fixing rolling steel shutters

This shall be done as per standard specification No. Bd-T-56 page No. 511 and relevant item of schedule 'B'. The specifications lay down requirements of providing and fixing steel rolling shutters with accessories locking arrangement top hood cover and painting in three coats of synthetic enamel paint of approved quality and shade.

MATERIALS

The rolling shutters shall conform to IS:6248:1979. Rolling shutter shall be supplied of specified type with accessories Such as top cover (in or out] handles, bearings, springs, axles, locking arrangements, guide rails, iron pulleys push and pull arrangements This shall be of approved quality, make and type, 10 gauge (MS solid laths or grill) The size of the rolling shutters shall be as specified in the drawings The shutters shall be constructed with interlocking lathe sections foamed from cold rolled steel strips not less than 0.9 mm thick and 80 mm wide for shutters up to 3.5 m width and not less than 1.25 mm thick and 80 mm wide for shutters 3.5 m width and above unless otherwise specified. Guide channels shall be of mild steel deep channel section and or rolled pressed or built up (fabricated) jointless construction. The thickness of sheet used shall not be less than 3.15 mm. Head cover shall be made of M.S. sheet not less than 0.9 mm thick for shutters upto 3.5 m width. For shutters having width 3.5 mm and above the thickness of M.S. sheet for the hood cover shall not be less than 1.25 mm. The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong M.S. or Malleable C.I. brackets the brackets shall be

fixed on or under the lintel as specified with raw plugs and screws bolts etc.. Both the side guides and bottom rail shall be joint less and of shaft, spring etc. shall be of same material as that of lathe. The side guides fixed with plates welded to guides shall be property fixed with screws, bolts and concealed in plaster

The rolling shutters shall be self rolling type upto 8 Sq.mt clear area without ball bearing and upto 12 Sqm.. Clear area with ball bearing. If the rolling shutters are of larger size, then gear operated type shutters shall be used. The locking arrangement shall be provided at the bottom of shutters at bottom ends. The shutters shall be opened from outside. The shutter shall be either push and pull type as operated with special type of reduction / bevel arrangement operated with mechanical device. Shutter up to 10.20 - sqm. Or outside width less than 3 m shall be push and pull and shutter above 10.20 sq. m. or whose width is more than 3 m will be mechanically operated.

The shutters shall be complete with door suspension shafts, locking arrangements, pulling hooks, handless and other accessories.

WORKMANSHIP

Rolling shutters and top hood with all accessories shall be supplied of specified type and shall be got approved before fixing by the Engineer-in-Charge. The fixing shall be done in true line and level. The damaged work shall be made good to the level of original works. The fixing work shall be done to the entire satisfaction of the Engineer-in-Charge. After the erection and fixing, the rolling shutters with hood should be painted with on coat of approved primer and two coats of approved enamel paint (or any other approved superior quality paint as needed for protection against environment prevailing in the area)

10.4 MODE OF MEASUREMENT AND PAYMENT

The item shall include -

- a) Providing and fixing the rolling shutters of specified size, material with all accessories, locking arrangement and top hood cover.
- b) Painting the same with approved synthetic enamel paint in three coats.
- c) Redoing the damaged works

The item will be measured and paid in Sqmt.basis of the shutter area

G.I. HAND RAILING

(Sub Work No....., Item No.....)

The item shall comply as per standard specifications and item as described in Schedule 'B'

The item shall be executed as specified in the tender item and as shown on drawing. The vertical supports shall be properly fixed at base either in masonry or concrete by nuts and bolts duly embedded in the form, right anchorage holes in the vertical support to pass G.I. piping in it or welding to fix the G.I. pipes to supports together with M.S. cleats, etc. are included in this item. The G.I. piping shall be provided along with required specials, fixtures, fastening, etc. and G.I. piping shall be bent in circular or spiral railing pipes and shall be jointed by G.I. collar or welded as per necessity. The diameter of G.I. piping, number of rows size and type to vertical posts together with its centre to centre distance height, etc. shall be as specified in the tender item and in absence thereof as per the MJPs type design in force. The rate shall also include two coats of approved shade oil paint. Cost of all the materials which shall be procured by the Contractor, labor involved for executing this item is included in tender item. The measurements and the payment shall be on the basis of lengths in running meters occupied by the complete railing assembly in plan.

The agency should provide G.I. pipe railing having one meter height consisting 50 x 50 x 6 mm thick MS angles and vertical at 1.50 m c/c and additional post at every corner bends or curved point with three rows of 25 mm G.I. pipe of medium class variety of horizontal at 3 coats of oil paints over one coat of anti corrosive paint approved colour including cost of labour, transport, materials etc. complete C. I. Decorative post shall be fixed instead of M.S. angles as directed by Engineer-in-charge without any extra payment.

Mode of payment

The payment shall be made on running meter basis

Item No. :- Providing lowering, laying and jointing R.C.C. pipes-----for overflow --- Complete.

Please refer specification for Item no. 1 & 2 for sub work on 'Sewerage Collection System'.

Contractor shall provide R.C.C. S/S Pipes of required dia and class in standard length as per Schedule conforming to I.S. 458-1956 including cost of all Material, including all taxes (Centre and Local) transport to site of work. The pipes Shall be stacked along the alignment of the line in such a way so that minimum hindrance is created to the traffic / pedestrians. Cracked / damaged pipes shall be rejected out rightly. After the pipes are supplied by the contractor, the responsibility of security and safety shall still rest with the contractor the pipes are laid and jointed After supply of above material at the site of work by the contractor, the Same material shall be issued to the contractor on "Unstamped Receipt" The material Shall be kept at site with chowkidar by the contractor at his own cost. The site Engineer can check the balanced material any time at site store of the contractor, if Any shortage found the cost of short material with penal rate shall be recovered Through R.A. bill of contractor in single installment without any prior intimation.

The pipe shall be laid to line levels and slopes indicated on the Drawings or as directed by the Engineer, Sight rails or leveling instrument shall be Provided for this purpose by the contractor.

The handling and laying of the concrete pipes shall conform to IS 783-1959 (relevant Para). The joints shall be done as per paragraph 10.2.3.1 of I.S. 783-195. Any pipe damaged during lying shall be replaced by the contractor at his Cost. Proper alignment, tools and facilities shall be provided by contractor for Lowering the pipes, fittings in to trenches to prevent damages. Dumping shall not be Permitted. Chain pulley block may be used for pipes above 300mm. dia. All the joints shall be done leak proof, jointing, using spun yarn in C.M. 1:1 with hardcrete is preferred. The leaking joint shall be made Water tight at the cast of contractor, Cement will not be supplied by MJP for manufacturing of R.C.C pipes And any others allied works. The specification for (A) Excavation (B) refilling (C) Murum Bedding will be applicable same for the relevant items No. 1, 2, 3, 4, & 5 included in The agreement The pipes shall be inspected by the SGS/RITES and certificate to that Extent shall be produced by the contractor at his cast the

Contractor

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Executive Engineer

payment shall not be done Till receipt of SGS/RITES certificate.

Mode of payment

75% payment against supply of s/s R.C.C pipes and rubber rings at Site along with inspection certificates for SGS/RITES. Remaining 15% payment and will Be made after lowering lying jointing and 10% payment shall be released after Satisfactory water tight testing of the pipe line the item shall be measured and paid For one running meter length of actual pipe land including specials if any.

ITEM PROVIDING AND SUPPLYING C.I./D.I. FLANGED PIPES

Sub-Work No., Item No),

a) The item includes supply CI/DI flanged pipes as per latest IS and approved by Engineer-in-Charge. The cost of pipe should be including all taxes central and local, railway freight, transportation upto site of work or departmental store.

b) The item will be measured and paid as per running meter basis.

Item No:- Providing and fixing copper lightening conductor including copper rod etc complete

This shall be done accordingly to the detailed item mentioned in schedule B ABD SPECIFICATION No Bd-1 P No 539 . The rates adopted for 10 m length of copper tape . Rebate / extra rate for length beyond 10 m as per described in item.The lightening conductor shall be of copper rod of 20 mm diameter 1.5 M long with knob at the end and with conical spike at top .Copper tape conductor 20X3 mm size copper earth plate of 3 mm thick and 0.81 Sqm in area clamps, at 1 M centre to centre including providing and fixing 40 mm GI pipe up to 3 M height from ground and 0.5 M below ground including making all connections filling earth pit with charcoal, salt etc and refilling and watering etc complete as per the specification laid down in relevant IS codes..

Item No :- Providing and laying P.V.C. Water stops in between vertical wall and base slab etc complete.

Proprietary names where given by the Engineer in charge shall be taken only as a reference to quality . They do not oblige the contractor to use the product specified . However all water stops and joint fillers shall be got approved by the contractor before application in accordance with the instructions of the

Contractor

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manufacturer . Rubber water stops shall include a centre bulb and shall have a tensile strength of not less than 20.7 KN/M² and elongation at break of not less than 500 %

P.V.C. Water stops shall include a centre bulb and shall have a tensile strength of not less than 14 KN/M² and elongation at break of not less than 300 % . Water stops shall not be exposed to direct sunlight for long period . They shall be cleaned of all foreign materials before being carefully compacted around the water stop so that no voids or porous concrete remains . Where the concrete is reinforced adequate clearance between the water stops and the reinforcement shall be maintained to permit proper compaction of concrete.

Item No :- Providing and fixing reciprocating type machinery clean screen units etc complete

This shall be done as per detailed drawing and the sizes of sections mentioned in item and as directed by Engineer - in charge .

Item No :- Providing and laying cast iron with scraped non ferrus penstock of 600 mm dia etc complete

Penstock shall be of the following type C.I./M.S.of I.VI. / I.V.C. / Glenfield Kennedy make only with brass .This item shall also comply with recent circulars of M.J.P.and other concerned Government Departments

Item No :- Providing and fixing M.S. ladder etc complete

This shall be done according to the details mentioned in item of Schedule B of tender and as per relevant specifications .P.V.C. coating shall be done on flat bars etc of ladder to avoid corrosion or deterioration . P.V.C. steps shall be provided on vertical wall of sump and pump house at the cost of contractor . such P.V.C. steps are used in manholes of sewer laterals for reference.

Ladder shall be manufactured as per the details provided in the tender item. All the materials and labour required for executing the item are to be provided by the Contractor at his cost. The ladder shall be properly fixed at site as directed and the bottom and top shall be properly embedded in 1:2:4 CC block as directed at Contractor's cost. In order to have stiffness to the ladder, cross supports or stiffeners at suitable intervals as directed shall be provided of suitable M.S. flats duly embedded in walls or welded to the ladder. The specification for this item as

given in the Standard Specification Book (Red Book) published by PWD Department shall be followed.

Mode of Measurement & Payment & Payments

The item shall be measured and paid in Rmt basis.

Item No :- Dewatering the excavated trenches and pools of water etc complete

Please refer specification for item no. of Dewatering in sub work of 'Sewerage Collection System'.

This item is provided for dewatering during excavation of entire work when it is not possible to bail out the water manually the item includes all machinery , fuel labour etc . The payment shall be made 50% after full depth & remaining 50% shall be made after completion of R.C.C. Work

This item shall comply as per standard specification No Bd- A-9 on Page No 261

Item No :- Providing and fixing approved make M.S. Grill etc complete.

This item shall be executed as per the detailed specification and as per relevant item described in schedule B.

Item No :- Designing the pumping station etc complete.

This item shall be complied as item described in schedule of the tender and directed by Engineer in charge.

Note :- Tentative sizes of sump and pump house is considered to work out the quantities for tender , but the agency has to submit final and approved detailed drawing & design showing structural and hydraulic calculations for the same as per obligatory condition and mechanical specification of tender .Necessary required accommodation to install and easy for maintenance and repairs of pumps of intermediate stage and ultimate stage should be considered in detailed drawings submitted by the agency.

Structural Designer has to visit the site before commencement of work , similarly he has to visit and certify during important concreting works . Engineering in charge may direct to arrange the visit of V.N.I.T. representative or M.J.P. Consultant along with the structural Designer of the contractor & the charges shall be borned by the contractor.

Item No - BB masonry chamber

Construction of B.B. masonry valve chamber includes excavation to the required size and depth, Providing and placing in position PCC for levelling course, followed by 15 cm thick M:15 P.C.C. foundation bedding , The chamber walls shall be in B.B. masonry in c.m. 1:5 proportion and inside cement plaster in c.m. 1:3, and external cement pointing including precast R.C.C. frame and cover as directed by Engineer in charge etc complete. The curing shall be carried out as per the specifications before refilling the sides.

Item No Sluice gate

Providing of CI gates shall conform to IS specifications mentioned in the subwork of STP. Fixing in position CI sluice gate in position as per detailed drawing s and specification including operating pedestal, operating / connecting rod of required length, painting with 3 coats of anticorrosive paint etc complete.

Item No - CI Dapuri type steps

Fixing in position Dapuri type steps made of CI with proper anchorage and providing and applying 3 coats of anticorrosive paint etc complete.

Item No - Oil Emulsion (oil bound) washable distempering.

Materials

Oil emulsion (Oil Bound) washable distemper (IS:428:1969428) of approved brand and manufacture shall be used. The primer where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day"s work shall be prepared. The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight"s work, and the same shall be kept in the joint custody of the contractor and owner.

Preparation of the Surface.

For new work the surface shall be thoroughly cleaned of dust, old white or color wash by washing and scrubbing. The surface shall then be allowed to dry for at

least 48 hours. It shall then be sand papered to give a smooth and even surface. Any evenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry. In the case of old work, All loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc. Pitting in plaster shall be made good with plaster of Paris mixed with the color to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat:

The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described.

Note: If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat alkali resistant priming Paint conforming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

Cement Primer coat

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalis present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints. Primer coat shall be preferably applied by brushing and

not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

Preparation of the Surface

The surface shall be thoroughly cleaned of dust, old white or color wash by washing and scrubbing and all cracks, holes and surface defects shall be repaired with gypsum and allowed to set hard.. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered smooth and wiped clean to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry. The surface so prepared must be completely dry and free from dust before distempering is commenced. In the case of walls newly plastered, special care shall be taken to see that it is completely dry before any treatment is attempted.

Application

The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied. The Specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under.

Distemper Coat:

For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of dis-

temper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat. For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each day's work, brushes shall be thoroughly Washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

CPWP SPECIFICATIONS 2009 554

The specifications in respect of scaffolding, protective measures and measurements shall be as described under

Rate

The rate shall include the cost of all labor and materials involved in all the above operations (including priming coat) described above.

The rate shall include all labour, material, equipments and tools for carrying out the following operations.

- Providing the primer and distemper and mixing the distemper.
- Scaffolding
- Preparing the surface to receive the primer and finishing coats.
- Applying the priming coat
- Applying the distemper as specified above in the number of coats, mentioned in the item.

Mode of Measurement & Payment

This item will be measured and paid in Sqm basis.

Item no 17 White washing with lime.

Scaffolding

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No bal-

lies, bamboos or planks shall rest on or touch the surface which is being white washed. For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. Note : In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls. For white washing the ceiling, proper stage scaffolding shall be erected.

Preparation of Surface

Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings and foreign matter. In case of old work, all loose particles and scales shall be scrapped off and holes in plaster as well as patches of less than 50 cm area shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer-in-Charge, the entire surface of old white wash shall be thoroughly removed by scrapping and this shall be paid for separately. Where efflorescence is observed the deposits may be brushed clean and washed. The surface shall then be allowed to dry for atleast 48 hours before white washing is done.

Preparation of Lime Wash

The lime wash shall be prepared from fresh stone white lime (Narnaul or Dehradun quality). The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 cubic decimetre of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg of lime. Indigo (Neel) upto 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 litres per kg. of lime to produce a milky solution.

Application

Contractor

No. of correction

Executive Engineer

The white wash shall be applied with moonj brushes to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries. Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer-in-Charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on. For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed. For old work, after the surface has been prepared as described above in earlier para a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patches do not appear. The washing on ceiling should be done prior to that on walls.

Note : In case of Hessian ceiling, on no account, lime shall be used as it rots cloth and hessian. Protective Measures

Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

Measurements

Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

Measurements for Jambs, Soffits and Fills etc. for openings shall be as described in Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area. Corrugated non-asbestos cement sheet 20% Semi corrugated non-asbestos cement sheet 10%

Cornices and other such wall or ceiling features, shall be measured along the girth and included in the measurements. The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared. Work on old treated surfaces shall be measured separately and so described.

Rate

The rate shall include all material and labor involved in all the operations described above.

Finishing

Dehradun quality lime and the wash will be mixed to a thicker consistency. The other details and specifications as described will follow.

White washing with whiting

Preparation of Mix

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. Two kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use. Other specifications described in 13.14 shall apply in this case also.

Color washing

It item refers to providing and applying of approved colour wash to surfaces which are not given any finishing. The mineral colors, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No color wash shall be done until a sample of the color wash of the required tint or shade has been got approved from the Engineer-in-Charge. For all colour wash, a sample must first be applied, allowed to dry and approved by the Engineer-in-Charge before the work proceeds. The color shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor. For new work, the priming coat shall be of white wash with lime or with

whiting as specified in the description of the item. Two or more coats, shall then be applied on the entire surface till it represents a smooth and uniform finish. For old work, after the surface has been prepared as described in 13.14.2 a coat of color wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of color wash, as stipulated in the description of the item shall be applied over the entire surface. The color washed surface shall present a uniform finish. The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed. It should be noted to large surface such as a the walls of a room . Care must be taken to mix sufficient colour wash to complete the whole surface to be treated, otherwise it is taken to mix impracticable to obtain exactly the same shade of colour in two successive mixtures. Sufficient gum or rice size should be added to prevent the colour wash coming off when rubbed with fingers

Preparation of surfaces :

The surfaces shall be prepared by brooming down, brushing or other means as may be ordered by the Engineer-in-Charge. The surface shall be thoroughly cleaned down and freed from all foreign matter before the base coat is applied. Other specifications as described CPWP SPECIFICATIONS 2009 552

Sub-base: Sub-base of two coats of white wash shall be applied as specified in Item No. Bd.P-1.

Application of colour wash: The colour wash shall be applied over the base coat. It shall be applied in the same way as white wash. The number of coats shall be as mentioned in the item, each coat being applied after the earlier coat has dried.

Mode of measurement : Per sq m

Item No.:- Providing and applying plastic emulsion paint-----etc. complete.

This shall be done as per standard specification No. Bd-p-6 and Bd-o-8

Page No. 414 and 406 respectively.

Colour and shade shall be of standard make and Same shall be got approved from Engineer-in-charge. Best workmanship for paintings shall be used. The external faces of structure shall be painted with waterproof cement Paint and internal faces of structure shall be painted with plastic emulsion paint.

Item no. - Aluminum Doors and Windows

This specification covers major Aluminum works like Aluminum windows Aluminum door, shutters, pipe railing, etc. Deviations to this specification are not permissible unless it is brought to OWNER's attention with adequate supporting data and are with OWNER's written approval. Dimensions and data shall be in metric units.

Material

Aluminum Windows

The Aluminum windows shall conform and sections shall be less than specified in 1S: sections.

Aluminum windows may include all type of window fixed, partially fixed, partially side bottom hung, top hung, center hung, etc. or composite of any two or more. The Aluminium channels shall be square and flat. The members shall be cut to require length, mitered and electrically flame butt-welded. Sub dividing bar units shall be tennoned and riveted into the All the frames shall have the corners welded to a true right angle and welds shall be neatly cleared off. Couplings, mullions, transom and weather bar shall be provided as per requirements. The outer frames shall be provided with fixing forces centrally in the web of the sections and fixing the frame of the sections to Masonry / RCC. Mastic cement shall be used for making the joints watertight. The sections of the windows shall be such that after fixing the glazing the same should not bend and shutters shall be smoothly operative. The necessary accessories such as hinges, stays, stopper hold, etc. shall be provided per requirement. Projecting type hinged shall be fitted with bronze or barns peg stays, 30 cm long with all windows shall be provided with handles of brass or bronze.

Ventilators

Top hung ventilators shall be fixed with plain hinges riveted / welded to the fixed frame. A brass or bronze peg stay 30 cm long as in windows shall be provided. Center hung ventilators shall be hung on brass or loaded tin bronze cup pivots riveted to the inner and outer frames of the ventilators to permit the ventilators to swing through an angle of approximately 85 deg. The opening position of the ventilators shall be so balanced to keep it open at any desired angle under normal weather

conditions. A bronze spring catch shall be fitted in the center of the top her of the ventilators for the operation of the ventilators. This spring catch shall be screwed to the frizz with brass screw shall close into a mild steel malleable iron catch plats riveted or welded to outside of the outer ventilators frame bar. A brass cord pulley wheel in mild steel or cord eye.

Finishing

All the steel surfaces shall be thoroughly cleaned free of mist, scale or dirt and mill scale by pickling and phosphating and before erection painted with one coat of finishing coats of synthetic enamel paints (or any other approved superior quality paint as needed for protection against environment prevailing in the area) of approved shade and quality.

Glazing

Glazing of specified shall be provided on the outside of the and otherwise specified beading of approved shape and shall be used for fixing Special metal cash putty of approved make shall be used.

Aluminium Door frames

Aluminium door frames should be fabricated from sections conforming to 1S: and member shall be free from defective and crate and shall be and fabricated as per drawing. The welding shall be created and fixed with Mg hold fasts and grouted with cement concrete M:15. The frames shall be painted with one coat of approved quality primer and 2 coats of approved quality and paint for any other approved superior quality as needed for protection against environment prevailing in the area.

Aluminium Doors

Standard sectional Aluminum door

Aluminium door made out of standard Aluminium section shall be from heavy or medium heavy uniform steel section. The type, over all size, design shall be as and drawing. The providing of a threshold or bar also to be provided to is in position for fixing in floor, 75 mm extra vertical members also should be provided. Sides shall be fixed with six hold fasts. The weights have different. Sections shall

not be less than what is provided in IS: . Provision for fixing mortise lock and aldrops to be made. For double shutters concealed tones. Bolt is to be fixed.

The bottom panel of door should be fixed either by 5.5 mm thick glass or 19 mm plywood. Frames shall have arrangements for fixing putty, clips wooden bead-ing required lugs, screws, fittings etc. Measurement will be in sq. m and will be re-quired out to out of the frame.

This shall consist of double or single gate depending on the size of the open-ing. This shall consist of vertical double channel each 20.5 mm and top and bottom of T 40 10 with 38 mm steel pulley or ball bearings in every fourth double channels which collapsible gate is not provided within the opening, and is fixed along the outer surface T iron at top may be replaced by flat 40 x 10 mm. The fixing of T and channels shall be permanent, rigidly fixed .

Item no. - Structural steel work

Please refer specification for item for RCC in which the specifications for structural steel is given. In addition the PWD handbook for specification be referred.

Item no. SFRC frame & cover

Please refer specification for item no. for circular manhole chamber of sub work 'Sewerage Collection System'.

PROVIDING AND ERECTING WIRE FENCING (Sub Work Item No.)

Providing and erecting 1.5 meter high wire fencing with seven rows of barbed wire supported on mild steel angles (50 x 50 x 6 mm) at 2.5 meters centre to centre including excavating pit for foundation, fixing posts in cement concrete blocks of size 45 x45 x 45 cm, fastening the wire and painting the mild steel angles with one coat of red lead primer and two coats of painting etc. complete.

MODE OF MEASUREMENT

This item will be measured and paid as per Rm. basis.

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Technical Specifications

Contractor

No. of correction

Executive Engineer

A. Raw Sewage Pumping Station of MLD Capacity

Receiving Chamber

The deep gravity outfall sewers will discharge the raw sewage into a Receiving chamber. The function of the Receiving chamber is to distribute the flow for process units. The Receiving Chamber shall be designed for ultimate peak flow. The Receiving chamber shall consist of sluice gates on upstream for flow regulation. In the sidewall of the Receiving chamber, sluice gates shall be installed such that it is possible to operate them manually, inspection as well as operation by standing on a platform constructed at a suitable elevation adjoining and circumventing the receiving chamber. The receiving chamber shall be of adequate size to meet the requirements of workability inside it. The receiving chamber shall be open to sky and shall be water tight to prevent seepage of the sewage out of the receiving chamber. The entire construction is in M30 grade concrete and as per IS 3370. RCC access platform minimum 1000 mm wide with railing as per specifications shall be provided on one side of the chamber:

Ultimate Average flow	:	MLD
Peak factor	:	-----
Ultimate Peak Flow	:	MLD
Number of Units	:	1 (One)
Detention period	:	30 Sec at Peak Flow
Min Free board	:	0.50 m above FGL

Coarse Screen Channels

One mechanical screen working and one manual screen standby of 20 mm clear spacing and each screen shall be provided of 100% peak flow capacity. The mechanical and manual bar screens shall be made of 10 mm thick Stainless Steel (SS 304) flats respectively. The mechanical coarse screens shall be of Inclined Rake Type of 20 mm opening as per the specifications detailed elsewhere in the tender. Bin and chute arrangement shall be provided to take the screenings to the screenings dropped from chute will be collected in a wheel burrow. Manually operated CI gates are provided at the upstream and downstream ends to regulate the flow.

Adequate RCC Platforms shall be provided at the upper level to enable operation. Railings shall be provided around the entire periphery of the platform. The entire

structure is to be M30 concrete and as per IS 3370 including the platform. RCC staircase 1000 mm wide shall be provided for access from the ground level to the top of the unit & to the operating platform.

Ultimate Average flow	:	MLD
Peak factor	:	-----
Ultimate Peak Flow	:	MLD
Number of Units	:	1 Mechanical (Working) + 1 Manual (Standby) each of 100% Peak Flow capacity
Approach Velocity at Average Flow (m/sec)	:	0.3
Velocity through Screen at Average Flow (m/sec)	:	0.6 maximum
Velocity through Screen at Peak Flow (m/sec)	:	1.2 maximum
Min Free board	:	0.50 m above FGL
Wheeled Trolley	:	1 No.

All other accessories, whether specified or not, but required for completeness of contract shall be in contractor's scope.

Raw Sewage Pumping Station

3.1 Sump and Pumps

Sewage enters into wet well of the pumping station after screening. The wet well shall be circular/rectangular in shape and shall be designed for an ultimate average flow of MLD. The capacity of the wet well should be kept such that the detention time in the wet well shall be minimum 5 minutes of ultimate peak flow and the maximum detention time shall not exceed 30 minutes at ultimate average flow. The entire structure is to be M30 concrete and as per IS 3370 including the platform. Following criteria shall be considered to size the sump:

1. That the pump of the minimum duty/ capacity would run for at least 5 minutes considering no inflow or
2. The capacity of the sump is to be so kept that with any combination of inflow and pumping the operating cycle for any pump will not be less than 5 minutes and
3. The arrangement of the submersible pumps as per pump manufacturer's data i.e. spacing between pumps, minimum space between pump and wall etc.
4. The side water depth (live liquid depth) shall be minimum 1.5 meter. In addition to the above liquid depth an additional depression shall be provided

to ensure adequate submergence of the pump as per the manufactures recommendations Pumping station should have a room adequate for installing electrical panels. Suitable arrangement should be provided for lifting of pumps.

5. The effective liquid volume shall be provided below the invert level of the screen chamber after leaving provision for a minimum of 0.1 m.

Necessary bypass arrangement shall be provided to be used during the shutdown of the plant.

IS: 3370 and IS: 4111 (part 4) shall be followed for the design and construction of wet well.

Bidder shall note that, the civil works for raw sewage pumping station shall be carried out for ultimate average flow whereas, electro-mechanical works for pumping station shall be carried out for intermediate average flow). Hence, Pumping machinery shall be designed for present MLD average flow and a peak factor of Adequate space shall be provided for the pumps that need to be installed in the wet well for future MLD average flow and peak factor of The pumps shall be Submersible raw sewage pumps with centrifugal, non-clog type design. The speed of pump shall not be more than 1500 rpm. The impeller should be of a non-clog design with smooth passage and solid handling capability of 100 mm size. The pumps will have automatic coupling arrangement at discharge end for removal and a guide pipe and chain in SS 304 will be provided for removal and lowering of pumps. Pump shall run smooth without undue noise and vibration. Vibration shall be limited as per BS 4675 Part I. The motor shall be squirrel cage type, suitable for three phase supply continuous duty with class 'F' insulation. Motor shall have integral cable parts and the cable entries shall be sealed. Complete rotor shall be balanced dynamically.

Design Flow (Ultimate Avg. flow) :	MLD
Minimum Retention Time :	5 minutes minimum at peak flow.
No. of Pumps for present	
Flow :	MLD with Suitable Head (2W+1S)
Type of Pumps :	Submersible type non-clog design
Solid passage size :	100 mm max.

Through Pumps

Insulation	:	Class F
Protection	:	IP-68

Wet well Specific Requirement, Material of Construction and Accessories:

- i. Number of Units : (1) One designed for peak flow
- ii. Pumping Station Material of Construction : RCC
Wet well / Sump

The size of the sump shall be suitable to accommodate the number of pumps required for operation with easy maneuverability. Electrical panel of the Pump House shall be placed in such a manner to avoid corrosion from gases. Either, it can be clubbed with MCC panel or necessary protection can be given.

Raw Sewage Sump shall be provided with following:

Electrical Hoist - comprising of I-Girder and a 1½ ton or more chain pulley (the chain pulley block capacity to be 1½ Ton or 1.5 times the maximum single unit/ weight that may be required to be removed for maintenance) with horizontal travel on the I-beam.

Pumps Configuration	:	As mentioned above
Liquid	:	Raw Sewage
Specific gravity	:	1.05
Temperature	:	Min. 20° C
Efficiency	:	more than 70%
Installation	:	Fixed.
Casing	:	Cast Iron IS 210 Gr. FG 260
Impeller	:	Cast Iron IS 210 Gr. FG 260
Shaft	:	AISI 410
Cable gland	:	Cast Iron IS 210 Gr. FG 260
Motor Body	:	Cast Iron IS 210 Gr. FG 260
Seal cover	:	Cast Iron IS 210 Gr. FG 260
Automatic Coupling	:	CI
Duck foot bend	:	CI
Guide Pipe	:	SS 304
Lifting chain	:	SS 304
Fasteners	:	MS with GI coating

Contractor

No. of correction

Executive Engineer

Testing of Pumps at Manufacturers Premises:

- a) Hydrostatic Testing: All pressure parts of pumps prior to assembly, shall be subjected to hydrostatic tests to the satisfaction of Executive Engineer at 1.5 times the maximum pressure obtained with the delivery valve closed and suction pressure at maximum, or twice the working pressure whichever is higher for a duration of 10 minutes.
 - b) Balancing Test: Impeller and pump rotating assembly shall be dynamically balanced.
 - c) Performance Test: Each pump shall be tested for full operating range individually to BS: 5316: Part 2. Test shall be carried out for performance at rated speed with minimum NPSH as available at site.
 - d) Pump performance shall be within the tolerance limits specified in BS: 5316: Part 2.
- 3.2 A suitable plant bypass shall be provided from the pumping station to divert sewage in case of emergency.

SUB WORK NO. 4 & 6: - Sewage Pump House

Item No.1 to 3: - Providing and casting in situ Cement Concrete of trap/ granite / quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer- in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with CM 1:3 of sufficient minimum thickness if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) **In RCC M-200 -All types of Columns**

Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) **In RCC M-200 - For Beams / Braces / Lintels.**

Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) **In RCC M-200 - Slabs / Landings / Vertical Walls / Waist.**

1.1. R.C.C Works: -

1. R.C.C works as per I.S.S. 456-2000 (latest edition) in R.C.C M-200 and M-250 with 12mm to 20mm gigue metal. The work shall also be carried out standard specifications No. Bd-F-3, Bd-F-22-23-24 on page No. 282, 292 and 293 respectively.
2. R.C.C words in contact with sewage shall be executed as per I.S.S 3370 part I and II in R.C.C M-250 structure shall be finished with 20-mm thick Cement plaster in C.M.1:2 from inside in sulphate Resistant cement.

1.1. MATERIALS

1.32.1. Cement.

43 grate Ordinary port land sulphate Resistant cement of PCMC Approved Cement Company is only admissible.

1.32.2. Sand

This shall be clean, hard strong. Uncoated and well graded particles, the Sours of sand will be approved by Executive Engineer, and in no case clay, silt, admixtures will exceed 3% by weight or volume. Screening and washing shall be done to stand to confirm specification. All sand shall pass through a screen with 3/16" mash only sand is permitted for R.C.C work of all grade for Construction of RCC compound wall & others works quality of sand shall only be used.

1.32.3. Coarse Aggregate

All aggregates shall conform to I.S 383-1963, IS 515-1969 and should be as specified in I.S 456-2000, gauge of metal to be used shall be decided. According to the type of works by the Engineer-in-charge the metal of approved Qualities to be brought from quarry approved by Executive Engineer, and P.W Department.

1.1. Storage of Material

Sand and coarse aggregates shall be properly and separately stored on site on hard ground so as to keep them safe from admixtures of foreign material such as clay, grass etc. it shall be as per I.S.456-2000.

1.1. Form Work

The steel centering shall be preferable. If wooden formwork is used, it shall consist of planks not less than 40 mm thickness and of strong props etc, This Shall be provided as per I.S 456-2000, clause of formwork. Timber used for Formwork shall be best hard wood and got approved by Engineer-in-charge. The item is covered in the rate either for plain or R.C.C items for bottom slab, beams etc. P.V.C or plastic paper should be provided over the centering to make the same Watertight.

1.1. Separators.

From bottom covers of beam, slab, columns, vertical Walls, etc. Separators of pre-cast cement mortar block of suitable size will be used and tied to the Reinforcement by binding wires between layers of reinforcement. Separators or M.S Case required over to the bars will be ensured beyond about as per I.S.456-2000 and I.S.3370-1965 part-II clause 7.2

1.1. Water

The water used to be as per I.S 456-2000, approved measures for water will be provided by the contractor the amount of water to be used will be decided by the workability and strength consideration which will be assured by the Contractor.

1.1. Concrete mixing

Concrete shall be only machine mixed as per standard practice.

1.1. Placing

The form work shall be just moisture before placing of concrete the Concrete shall be placed in position within 20 minutes after adding water to the Concrete it shall be slowly deposited in its place in uniform layers it should Generally comply with I.S 456-2000 under clause No. 12.2.

1.1. Tamping

While concrete is being placed in position it shall vigorously rodded and tamped by bars of appropriate size and other means to ensure dense concrete and Complete filling of forms. All around and in between the reinforcement the efficiency of tamping and consolidation will be judged by complete the efficiency of tamping and Honey combing after removal of forms and any deficiency in this respect will result in Pulling down and redoing of affected work at the cost of contractor. For work of 'any magnitude or importance. Mechanical vibrators of both immersion and surface Type will be used as a rule; no work without mechanical vibrator will be permitted. When concrete is so vibrated the water cement ratio will least practicable.

1.1. Curing

All R.C.C works will be watered and kept constantly wet for at least 21 Days after casting by means of wet gunny bags this operation shall start immediately. After initial set of concrete out satisfactorily and actual expenses made shall be recovered from the contractor, bill without any prior intimation.

1.1. Removal of forms.

Removal of forms will be carried out as below subjects to the prior approval Of Engineer-in-charge in writing.

- a) Columns: - 48 hrs, or as may be directed by the Engineer-in-charge.
- b) Side of beam: - 3 days.
- c) Vertical wall: - 6 days.
- d) Bottom of slab/chhajja / canopies etc.: - 15 days.
- e) Bottom of beam: - 14 days. Unto 5m. Span.
- f) Bottom of beam above: - 21 days. 5 m, span.

1.1. Inspection

The work at each stage of operation i.e. completion of form work, Completion of assembling and placing reinforcement concreting removal of forms must be get inspected by the Engineer-in-charge or Sub Divisional Officer in charge of the work who will record necessary certificate to be done in the presence to Engineer In-charge or his authorized representative for major work such as centering Reinforcement of slab etc, shall be checked by the contractor designer before Concreting at the cast of contractor in the presence of Engineer-in-charge.

1.1. Finishing

All R.C.C. works will be finished as provided in the item concrete surface not in contact with form work and not subjects to any further finish will be finished smooth by a float to parents a uniform appearance. Surface to receive plaster or rendering will immediately on removal of Forms be roughened by extensive hacking by a pointed tamping tool in all cases Where is it required to match with rest of the structure and present harmonious appearance to be decided by Engineer-in-charge, such fishing included in the rate of contract but will not be measured.

1.1. Testing

i. Cube

On any day when concreting of M-2000 and after mix is done for 4 Hours or 5 cum and more, concrete cubes of 15cm, x25cm, x15cm, shall be casted Per day equally spread over period of concrete. Every time seven cubes will be Taken for testing crushing strength three No's of cubes at 7 days and three No's of Cubes at 28 days and one at 3 month the seventh cube will be kept as reserved to Be tested immediately after 28 days in case of the cubes tests 7 days 28 days Show unsatisfactory result the casting and curing and testing of for moulds etc. The cost of contractor the contractor shall make his own arrangement for moulds etc. Number of cubes shall be taken out as per recent circular or as directed by Engineer-in-charge., cubes shall be tested in the laboratory of government Engineer College at the cast of contractor & cube test certificated shall be produce by the Contractor at the time of submission of bill.

ii. Mater

The contractor shall test the samples of cement sand coarse aggregate, etc. required for R.C.C work at this own cost in the laboratory of Government Engineering college and submit the result to the department for according necessary Approval for the same various tests of each material shall be carried out as per I.S. and Recent circular at the cost of contractor only.

iii. The minimum strength of 15x15x15cm. Concrete cube shall be as under.

Grade of concrete	7 days period	28 days period	3 Months, period
M-200	135 kg/sq. cm.	200 kg/sq.cm	220 kg.sq.cm.
M-250	170 kg/sq.cm.	250 kg/sq.cm.	275 kg/sq.cm.
M-300	kg/sq.cm.	kg/sq.cm.	kg/sq.cm.

The place where R.C.C is to laid shall be absolutely dry and it shall Be maintained dry from the time of starting the work unto six hours after the work is Completed (i.e., still concrete is set). A pit shall be excavated to such a size and depth that by dewatering from this pit will keep the ground water table below the level where Concreting is to carry out. The contractor should keep the pump of required ready at the Time of work. The rate of providing and laying concrete shall include expenditure or Keeping and maintaining ground dry.

1.1. General

In general, RCC work is to be executed as per IS: 456-2000 or its latest revision. The water storage tanks / reservoirs shall be followed by IS: 3370 Part I to IV & latest revision. Steel reinforcement bars shall be of High Yield Strength Deformed (HYSD) / TMT steel bars as per IS: 1786 and shall be free from corrosion, loose rust scales, oil, grease, paint, etc. Wire mesh or fabric shall be in accordance with IS: 1566. The steel bar shall be capable "of being bent without fracture. Bars shall be bent accurately and placed in position as per design drawing and bar bending schedule and bound together tight with 20 SWG annealed steel wire @ 10 kg/ton of reinforcement at their point of intersection. Formwork and shuttering shall be made with steel plate close and tight to prevent leakage of cement slurry, with necessary props, bracings and wedges, sufficiently strong and stable and should not yield on laying concrete and made in such a way that they can be slackened and removed gradually without disturbing the line, level and the shapes of concrete. For slab and beam small camber should be given in centering, 1 cm per 2.5 m with a maximum of 4 cm for quick drainage of water. Centering should not be removed before 14 days in general (4 days for RCC columns, 10 days for roof slab, and 14 days for beams). The centering and the form work shall be strong enough to take the shocks of the Mechanical Vibrators.

The grade of concrete to be used shall be as mentioned in specifications / shown on drawings.

Table – Preliminary Work Test

Minimum Compressive Strength of 15 cm cubes at 7 and 28 days after mixing, conducted in accordance with IS:516 Class	Test N/mm ²		n/mm ²		Maximum Size of Aggregate mm	Location for Use
	At 7 days	At 28 days	At 7 days	At 28 days		

M40	33.5	50.00	27.00	40.00	20	As indicated in the specifications or as
M35	30.00	44.00	23.50	35.00	20	-do-
M30	25.00	38.00	20.00	30.00	20	-do-
M25	22.00	32.00	17.00	25.00	20	-do-
M20	17.50	26.00	13.50	20.00	20	-do-

The coarse aggregate shall usually be 20 mm to 12 mm gauge unless otherwise specified. For heavily reinforced concrete members as in the case of ribs of main beams the maximum size of aggregate should usually be restricted to 5 mm less than the minimum clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement whichever is smaller.

1.1. Mixing is done in the same manner as in PCC.

Before laying the concrete, the shuttering shall be clean, free from dust, dirt and other foreign matters. The concrete mix shall be mixed in the drum for at least 2 to 2.5 minutes. The concrete shall be deposited (not dropped) in its final position. In case of columns and wall, it is desirable to place concrete in full height if practical so as to avoid construction joints but the progress of concreting in the vertical direction shall be restricted to 1.2 meter. Care should be taken that the time between mixing and placing of concrete shall not exceed 20 minutes so that the initial setting process is not interfered with. During the winters concreting shall not be done if the temperature falls below 4°C.

Concrete shall be compacted by mechanical vibrating machine until a dense concrete is obtained. The vibration shall continue during the entire period of placing concrete. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to the dry mixture. Over-vibration which will separate coarse aggregate from concrete shall be avoided. After removal of the form work in due time, the concrete surface shall be free from honey combing, air holes or any other defect.

Following Indian Standards as revised most recently along with amendments will be followed for the works included in the contract.

IS: 8112	Ordinary, Portland cement
IS: 383	Coarse and fine aggregates from natural sources for concrete
IS: 456-2000	Code of practice for plain and reinforced concrete
IS: 516	Method of test for strength of concrete
IS: 2386	Methods of test for aggregates for concrete (Part I to VI)
IS: 3414	Code of practice design and installation of expansion and contraction joints in building.
IS: 3370 Part-I to IV	Code of practice for water storage tanks

Concrete shall be laid continuously, if laying is suspended for rest or for the following day the end shall be shuttered and vibrated to achieve dense concrete and made rough after de-shuttering for further jointing. When the work is resumed, the pervious portion shall be roughened, cleaned and watered and a grout of neat cement shall be applied and the fresh concrete shall be laid. For successive layer the upper layer shall be laid before the lower has set.

Pre-cast concrete shall be provided with lifting device.

1.1. Standards

Standards on special subjects have been mentioned elsewhere in this Para and also shall be followed.

1.1. Forms, false work or centering

1.48.1. Definitions

“Forms, formwork or shuttering” shall include all temporary moulds for forming the concrete to the required shape, together with any special lining that may be required to produce the concrete finish specified.

“False work or centering” shall consist of furnishing, placing and removal of all temporary construction such as forming, props and struts required for the support of forms.

1.48.2. Materials

Steel shuttering shall be provided as directed by the Engineer-in-Charge.

1.48.3. Forms

All forms shall be of mild steel approved by the Engineer-in-Charge and shall be fabricated and prepared water tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other incidental loads incident to the construction operations. All form shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be specified hereinafter. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer-in-Charge shall order to stop the work until the defects have been corrected.

All formwork shall be approved by the engineer-in-charge before concrete is placed within it. The contractor shall be required to submit copies of his calculations of the strength and stability of the formwork or false work but notwithstanding the Engineer-in-Charge's approval of these calculations, nothing shall relieve the contractor of his responsibility for the safety or adequacy of the formwork. Formwork shall be true to line and braced and struttred 10 prevent deformation under the weight and pressure of the unset concrete, constructional load, wind and other forces. The deflection shall not exceed 3 mm. Beam bottom shall be erected with an upward chamber of 2 mm per meter of the span. The form work for a column may be erected. One side shall be left open and shall be built up in sections as placing of the concrete proceeds. Before placing the concrete, bolts and fixtures shall be in position, and cores and other devices, used for forming openings, holes, chases, recesses and other cavities shall be filled to the formwork. No holes shall be cut in any concrete unless approved. Approved mould oil or other material shall be applied to faces of formwork in contact with unset concrete to prevent adherence of the non-staying concrete. Such coating shall be insoluble in water, non-staying and non-detrimental to the concrete and shall not be flaky or removed by wash water.

1.48.4. Tolerance in finished concrete

(As per IS code 456-2000, 0.1)

The form work shall be so made as to produce a finished concrete true to shape, lines, level, plumb and dimensions as shown in the drawing subject to the following tolerances, unless otherwise specified in drawings or directed by the Engineer-in-Charge.

For Deviation from specified

- a. Dimensions of cross-section of columns

And beams = -6mm +12mm

- b. Deviations of dimension of footings (See Note)

Dimensions in plane = -12mm +50mm

Eccentricity = 0.02 times the width of footing in the direction of deviation but not more than 50 mm

Thickness = +/- 0.05 times the specified thickness

Note: Tolerances applied to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels.

1.48.5. False work and Centering

Detailed plans for false work or centering shall be supplied by the contractor if specifically asked for by the Engineer-in-Charge at least 14 days in advance of the time the contractor begins construction of the false work. Notwithstanding the approval by the Engineer-in-Charge of any designs for false work submitted by the contractor, the contractor shall be solely responsible for the strength, safety and adequacy of the false work or centering. All false work shall be designed and constructed to provide the necessary rigidity and to support the loads from the weight of green concrete and shuttering and incidental construction loads. False work or centering shall be founded upon a solid footing safe against undermining and protected from softening. False work which cannot be founded on satisfactory footing shall be supported on piling which shall be spaced, driven and removed in a manner approved by the Engineer-in-Charge. The Engineer-in-Charge may require the contractor to employ screw wets or hardwood wedges to make up any settlement in the formwork either before or during the placing of concrete. Props of the upper storey shall be placed directly over those in the storey immediately below. False work shall be set to give the finished structure the required grade and camber specified on the plans.

1.48.6. Formwork and Construction Joints

Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a watertight joint. The form of the permanent construction joint shall be as shown on the drawings. Temporary construction joints shall have blocks of timber at least 75 mm thick, slightly tapered to facilitate withdrawal and securely fixed to the face of the stopping off board. The area of the key or keys so formed shall be at least 30% the area of the member. The blocks shall be kept back at least 50 mm from the exposed face of the concrete. Where reinforcement passes through the face of a construction joint the stopping off board shall be drilled so that the bars can pass through, or the board shall be made in sections which a half round indentation in the joint faces

for each bar so that when laced, the board is a neat and accurate fit and no grout leaks from the concrete through the bar holes or joints.

1.48.7. Removal of Forms and False work

In the determination of the time for the removal of forms, false work and housing, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the settings of the concrete and the materials used in the mix. MS shuttering / formwork and scaffolding should be of standard reputed make to ensure better quality of concrete finish. Forms shall be removed in such a manner as not to injure the concrete and no formwork shall be removed before the concrete has sufficiently set and hardened. The minimum periods which shall elapse between the placing and compacting of normal Portland cement concrete for the various parts of the structures are given in the following table, but compliance with these requirements shall not relieve the contractor of the obligation to delay the removal of the forms if the concrete has not set sufficiently hard.

Forms shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subject at the time of removal of formwork. In normal circumstance, generally where the temperatures are above 20°C and where ordinary Portland cement is used, form may generally be removed after the expiry of the following periods, according to the Clause 10.3, IS: 456-2000.

1	Walls columns and vertical faces of all structural members	24 to 48 hours as may be decided by the engineer- in-charge
2	Slabs (Props left under)	3 days
3	Beam soffit (props left under)	7 days
4	Removal of props under slabs	7 days
	i. Spanning up to 4.5 m	14 days
	ii. Spanning above 4.5 m	14 days
5	Removal of props under beams and arches	21 days
	i. Spanning up to 4.5 m	
	ii. Spanning above 4.5 m	

Where sulphate resistant cement is used, manufacturer's instructions are to be followed. The Engineer-in-Charge may modify these requirements taking into account the type of cement and method of compaction used, and contractor shall obtain the Engineer-in-Charge's written approval for any decrease in time of stripping of the formwork given above. The contractor shall notify the Engineer-in-Charge when he proposes to strike of any formwork and no formwork shall be struck except in the presence of the Engineer-in-Charge or his representative

1.48.8. Reuse of Forms

Only mild steel formwork of best quality as per approved vendor list given by Engineer-in-Charge shall be used for concreting purpose. These shuttering shall not be reused unless it is properly scraped cleaned and repaired, so that it gives a plane, even, fair and dense concrete surface.

1.48.9. Cleaning and treatment of Forms

All forms shall be thoroughly cleaned of old concrete, wood shavings, sawdust, dirt and dust sticking to them before these is fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. should be scrupulously removed from the interior of the forms before concrete is poured. Wire brushes, brooms, compressed air jet and/or water jet etc. shall be kept handy for cleaning, if directed by the Engineer-In-Charge. Before formwork is placed in position, the form surface that will be in contact with concrete shall be treated with approved non-staining oil or composition, which is insoluble in water and not injurious to concrete. Care shall be taken that the oil or composition does not come in contact with reinforcing steel or stain the concrete surface. Burnt oil shall not be allowed to be used especially where the concrete surface will require finishing and/or plaster.

1.48.10. Materials for Concrete

1.48.10.1. Water

Water used for cement concrete mortar, plaster, grout, curing or washing of sand shall be clear and free from injurious amount of Oil, Acid, Alkali, Organic matter or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for mixing and curing concrete. In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time specified in the IS: 456 Code of Practice for Plain and Reinforced concrete. The Engineer-in-Charge may require the contractor to get the water tested from an approved laboratory at his own expense and in case the water contains any salts for an excess of acid, alkali, any injurious substances etc., the Engineer-in-Charge may refuse its use. And the contractor shall be required to arrange suitable water at his own cost.

1.48.10.2. Aggregate

General

Coarse and Fine Aggregates for concrete shall conform in all respect to PWD Specification / IS:383 Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. Aggregates shall be obtained from a source known to produce satisfactory material for concrete. Aggregates shall consist of naturally occurring sand and gravel or stone, crushed or uncrushed or a combination thereof. They shall be chemically inert, hard strong, dense, durable, clean and free from veins and adherent coatings and of limited porosity. Flaky and elongated pieces shall not be used. Whenever required by the Engineer-in-Charge the aggregates shall be washed by the Contractor before use in the work. The source of aggregates shall be approved by the Engineer-in-Charge and shall not be changed during the course of the job without his approval. Rejected aggregates shall be promptly removed from the work site by the contractor at his own expense.

Deleterious Materials

Aggregates shall not contain any harmful material, such as iron pyrites, coal, mica, shale or similar laminated materials, clay, alkali, soft fragments, sea shells, organic impurities etc, in such quantities as to affect the strength or durability of the concrete and in addition to the above, for reinforced concrete, any material which might cause corrosion of the reinforcement. Aggregates which are chemically reactive with the alkalis of cement shall not be used. The maximum quantities of deleterious materials in the aggregate, shall be in accordance with IS: 2386 (Part II). Methods of Test for

Aggregates for Concrete, shall not exceed the limit given in Table I of IS: 383. The sum of the percentages of all deleterious materials shall not exceed five. Deleterious materials also include material passing 75 microns IS sieve.

Coarse Aggregates

Coarse aggregate is aggregate most of which is retained on 4.75 mm IS: sieve. Coarse aggregate for concrete shall conform to IS: 383. These may be obtained from crushed or uncrushed gravel or stone and shall be clean and free from elongated, Flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter. Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits.

	Grading of Coarse Aggregates IS			Percentage Passing for Single			Percentage Passing for Grade		
	Sieve size (mm)			Sized Aggregate of Normal Size			Aggregate of Normal Size		
	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
63	100	-	-	-	-	100	-	-	-
40	85-100	100	-	-	-	95-100	100	-	-
20	0-20	85-100	100	-	-	30-70	95-100	100	-
16	-	-	85-100	100	-	-	-	95-100	-
12.5	-	-	-	85-100	100	-	-	-	90-100

The Engineer-in-Charge may allow graded aggregates to be used provided they satisfy the requirements and Table IV of IS: 383.

Fine Aggregates

Fine aggregates are aggregate most of which passes 4.75 mm IS sieve but not more than 10% passes through 150 microns IS Sieve. These shall comply with the requirements of grading zones I, II and 1II as given in Table III of IS:383. Fine aggregate conforming to grading zone IV shall not be normally used in reinforced concrete unless tests have been made by the contractor to ascertain the suitability of the proposed mix proportions and approved by the Engineer-in-Charge.

As per IS: 393 Table is given below:

IS: Sieve Designation	Grading of Aggregates			
	Grading Zone-I	Grading Zone-II	Grading Zone-III	Grading Zone-IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	5-90	75-100	90-100
600 microns	15-34	35-59	60-79	80-100
300 microns	5-20	8-30	12-40	15-50
150 microns	0-10	0-10	0-10	0-15

Note: To use the sand falling in Zone-IV IS: 383 shall be followed. Fine aggregate shall consist of natural sand resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies, or crushed stone sand or crushed gravel sand.

Sampling and Testing

Sampling and testing shall be carried out by the contractor, at the contractor's expense, in accordance with:

IS: 516 Method of test for strength of concrete

IS: 2386 Methods of test for aggregates for concrete

Storage of Aggregates

The contractor shall at all times maintain at the site of work such quantities of aggregates as are considered by the Engineer-in-Charge to be sufficient to ensure continuity of work.

Each type and grade of aggregate shall be stored separately on hard firm ground having sufficient slope to provide adequate drainage to rain water.

Any aggregate delivered to site in a wet condition or becoming wet at site due to rain shall be kept in storage for at least 24 hours to obtain adequate drainage, before it is used for concreting, or the water content of mix must be suitably adjusted as directed by Engineer-in-Charge.

Cement

General

The cement used shall be ordinary Portland cement conforming to IS: 8112 or as specified in the particular specifications/drawings or as directed by the Engineer-in-charge.

Storage on the site

The cement shall be stored in a suitable weatherproof building and in such a manner as to permit easy access for proper inspection and counting. The cement shall be stored in such a manner as to prevent deterioration. Cement of different types and brands shall be kept in separate stacks and marked accordingly. Cement older than two months shall not be used on site.

All cement stored on the site shall be arranged in batches, and used in the same order as received from the manufacturer. A cement register shall be maintained at site in which all entries shall be completed day to day, showing the quantities received date of receipt, source of receipt, type of cement etc, and also the daily cement consumption on site. This register shall be accessible to the Engineer-in-charge for his certification.

Rejection of Cement

The Engineer-in-charge may reject any cement as a result of any tests, thereof, notwithstanding the manufacturer's certificate. He may also reject cement, which has deteriorated owing to inadequate protection during storage from moisture or due to intrusion of foreign matter or other causes. Any such cement which is considered defective by the

Engineer-in-Charge shall not be used, and shall be promptly removed from the site of the work by the contractor at his own expense.

Other Materials

All materials including admixtures, joint filters and joint sealants not fully specified herein and which may be used in the work shall be of quality approved by the Engineer-in-Charge and he shall have the right to determine whether all or any of the materials offered or delivered for use in the works are suitable for the purpose. Contractor shall give the samples of materials to the Engineer-in-Charge and shall get them approved before procurement and use.

Reinforcement

All reinforcement shall be clean and free from pitting, loose mill scales, dust and coats of paints. oil or other coating which may destroy or reduce the bond.

Welded Joints

Welding of joints in reinforcement for bars of 28 mm dia and below shall not be allowed. However, in case of using welded joints for bars 32 mm and above the approval of the Engineer-in-Charge shall be obtained. The Engineer-in-Charge may require the Contractor, prior to the use of welded joints to have tests carried out at the contractor's expense to prove that the joints are of the full strength of the bars connected. The welding of the reinforcement shall be done in accordance with the recommendation of IS: 2751 code of practice for welding of mild steel bars for reinforced concrete construction. Special precautions are required in the welding of cold worked reinforcing bars. No extra payment for welded joints shall be made to the contractor unless specifically mentioned in the schedule of rates or bill of quantities and approved by the Engineer-in-Charge. Tack welding may be permitted by the Engineer-in-Charge under certain conditions for fixing reinforcements.

Reinforcement Splices

Laps & anchorage length of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller dia will guide the lap lengths. Laps shall be staggered as far as practicable and as directed by Engineer-in-Charge and not more than 50% of the bars shall be lapped at a particular section. Mechanical connections, for splicing reinforcement bars in congested locations may be used by the contractor, only if approved by the Engineer-in-Charge. Reinforcement bars shall not be lapped unless the length required exceeds the maximum available lengths of the bars at site. Unless otherwise specified the splices shall be wired contact lap splices as per the relevant standards. No splicing of vertical bars shall be allowed except at specified or approved horizontal construction joints. Splices in horizontal bars shall be lapped with at least one continuous bar between adjacent splices. The minimum spacing of splices in anyone run of bar shall be 6.0 m with splices in adjacent bars offset at least 3.0 m where walls or slab contain two layers of reinforcement, splices in opposite layer shall be offset by at least 1.50 m.

Fabrication and placement

Bars shall be pre-fabricated accurately to dimensions, forms and shapes, bending procedure shall be approved by the Engineer-In-Charge. Placing and tying of reinforcement shall conform to IS: 2502-1963 Code of practice for bending and fixing of bars for concrete reinforcement. Bar bending schedules for the reinforced concrete works shown on the drawings shall be prepared by the contractors and furnished to the Engineer-in-Charge at least two weeks before the commencement of bending. Dimensions shown as furnished by the collector's shall be his responsibility and approval of the schedule shall not constitute the approval of the dimensions thereon.

Field Control

The contractor shall appoint a qualified Engineer experienced in reinforcement cutting, bending and placing the same correctly, binding and cleaning before pouring the concrete. The reinforcement shall be continuously kept in correct position during connections.

Steel Reinforcement

The reinforcement shall be High Yield Strength Deformed (HYSD) bars or TMT bars of Grade Fe-500 conforming to IS: 1786-1985 shall be used unless otherwise specified.

Placement of reinforcement should be as per IS: 456 Clause 11.3. Approved Manufacturers: TISCO, SAIL and Rashtriya Ispat Nigam.

Structural Steel

Structural steel shall conform to IS: 226 and IS: 2062.

Electrodes for welding shall conform to IS: 814 or IS: 815 or equivalent.

All bolts and nuts shall conform to IS: 1367. Stainless steel nuts and bolts shall be of SS 307 type. All materials shall be of new and unused stocks. Manufacturer's test certificate shall be made available to the Engineer-in-charge when called for.

Storage

The steel reinforcement and structural steel shall be stored in steel yard in such a way as to prevent deterioration and corrosion, preferably at least 150 mm above ground by supporting on wooden or concrete sleepers at contractor's expenses.

Proportioning of Concrete

The determination of the water-cement ratio and proportions of the aggregates to obtain the required strength shall be made from preliminary tests by designing the concrete mix as per provisions laid down in IS: 456-2000 & IS: 10262 or its latest revision. Design mix shall be admissible only if contractor is able to manage the quality control of design mix e.g., weighbridge, proper water measuring device etc. and designing the concrete mix as and when source of any of the consistent of concrete is changed. If contractor fails to comply with the requirements of design mix concrete, he shall have to follow the nominal mix as tabulated below;

Recommended Water Cement Ratio (As per IS: 456-2000) Grade of Concrete	Nominal Mix of Concrete	Quantity of Water per 50 Kg. of cement (Max)
M 5	1:5:10	60 liters
M 7.5	1:4:8	45 liters
M 10	1:3:6	34 liters
M 15	1:2:4	32 liters
M 20	1:1.5:3	30 liters
M 25	1:1:2	26 liters

Cube tests shall be carried out by the contractor on the trial mixes before the actual concreting operation starts. Based on the strength of the concrete mix sanction for its use has to be obtained from Engineer-in- charge.

If during the execution of the works it is found necessary to revise the mix because of the cube tests lower strengths than the required one due to inconsistency of quality of material or otherwise, the Engineer-in- charge shall ask for fresh trial mixes to be made by the contractor. No extra claim shall be entertained due to such change in mix variations, as it is the contractor's responsibility to produce the concrete of the required grade. Great care shall be exercised when mixing the actual works concrete using the proportions of the selected trial mix. The final concrete mix shall have the same proportions of cement, fine and coarse aggregates and water as that of the approved selected mix. Where the weight of cement is determined by accepting the manufacturer's weight per bag, a reasonable number of bags should be weighed separately to check the next weight. Proper control of mixing water is deemed to be of paramount importance. If mixers with automatic addition of water are used water should be either measured by volume in calibrated buckets, tins or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked and certified and the Engineer-in-Charge's approval obtained. The Engineer-in-Charge may require the contractor to carry out moisture content tests in both fine and coarse aggregates. The amount of the added water shall then be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content IS: 2386 shall be referred to. No substitution in material, used on the work or alternation in the established proportions shall be made without additional tests to show that the quality and strength of concrete are satisfactory. No alternations shall be permitted without the prior sanction of the Engineer-in-Charge.

Mixing of Concrete

The mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixing equipment shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the solid materials are in the mixing time has elapsed. The mixing time in no case shall be less than two minutes. The mixer speed shall not be less than 14 and not more than 20 revolutions per minute. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. Hand mixing of concrete shall not be permitted at all.

Grades of Concrete

The different grades of concrete shall conform to the strength as required by IS: 456-2000. Standard deviation shall be calculated as stated in clause 14.5 of IS: 456-2000. The acceptable criteria for concrete shall be as stated in clause 15 of IS: 456-2000.

The assumed standard deviations as given in table 6 of IS: 456-2000 have to be followed. and are given here under:

Assumed standard Deviation Grade of Concrete	Assumed standard Deviation N/mm²
M 10	2.3
M 15	3.5
M 20	4.6
M 25	5.3

In order to get a quick idea of quality of concrete, the optional tests are conducted as stipulated in 14.1.1 of IS: 456-2000 and the results are analyzed according to table 5 of IS: 456-2000.

Concrete

In general design mix concrete shall be used conforming to IS: 456-2000. Nominal Mix concrete batching by volume can only be if the contractor is not able to adhere to the quality control provision of the design mix. The mix proportions for all grades of nominal mix concrete shall be provided corresponding to the values specified in Table-4.7 below for respective grades of concrete.

The maximum water-cement ratio for all concrete works shall be as specified in IS: 456-2000 and required by the Engineer-in-Charge.

Characteristics Compressive strength of Concrete Grade Designation	Proportion of cement: fine aggregate: coarse aggregate	Specified characteristic Compressive Strength at 28 days (N/mm²)
M 15	1:2:4	15
M 20	1:1.5:3	20
M 25	1:1:2	25

To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the same shall be made as frequently as directed by the Engineer-in-charge. The determination of moisture contents shall be according to IS: 2386 (Part III).

Controlled concrete

Controlled concrete shall be used on all concreting works except where specified Otherwise. The mix proportions for all grades of concrete shall be designed to obtain strengths corresponding to the values specified in Table 1 below for respective grades of concrete.

Grade of Concrete	Specified characteristic compressive strength at 28 days [N/mm²]
M 15	15
M 20	20
M 25	25
M 30	30

The maximum water cement ratio for all controlled concrete works shall be as specified in IS: 456 and Preliminary tests as specified in the IS code and required by the Engineer shall be carried out, sufficiently ahead of the actual commencement of the work with different grades of concrete, made from representative sample of aggregates and cement expected to be used on the job to ascertain the ratios by weight of cement, of total quantity of fine and coarse aggregates and the water cement ratio required to produce a concrete of specified strength and desired workability. The minimum cement content for each grade of concrete shall be as per Table-2 below. If the requirement of cement is found to be more than that specified below then such excess quantities of cement shall be used and for which no extra payment shall be made.

Minimum Cement Content in Concrete Grade of Concrete	Minimum cement content as per IS: 456 in kg. /cu. m of finished Concrete
M 15	310
M 20	360
M 25	410
M 30	500

At least 4 (four) trial batches are to be made and 7 (seven) test cubes taken for each batch noting the slump on each mix. These cubes shall then be properly cured and two cubes for each mix shall be tested in a testing laboratory approved by the Engineer at 7 (seven) days and others at 28 (twenty-eight) days for obtaining the ultimate compressive strength. The test reports shall be submitted to the Engineer. The cost of mix design and testing shall be borne by the contractor. On the basis of the preliminary test reports for trial mix, a proportion of mix by weight and water cement ratio will be approved by the Engineer, which shall be expected to give the required strength, consistency and workability and the proportions so decided for different grades of concrete shall be adhered to, during all concreting operations. If, however, at any time the Engineer feels that the quality of material being used has been changed from those used for preliminary mix design, the contractor shall have to run similar trial mixes to ascertain the mix proportions and consistency. The mix once approved must not be varied without prior approval of the Engineer. However, should the contractor anticipate any change in the quality of future supply of materials than that used for preliminary mix design, he shall inform the same to engineer and bring fresh samples sufficiently ahead to carry out fresh trial mixes. The Engineer shall have access to all places and laboratory where design mix is prepared. Design mix will indicate by means of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed. In designing the mix proportions of concrete, the quantity of both cement, and aggregate and water shall be determined by weight. All measuring equipment shall be maintained in clean and serviceable condition and their accuracy periodical checked. To keep the water cement ratio to

the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the same shall be made as frequently as directed by the Engineer. The determination of moisture contents shall be according to IS: 2386 (Part III).

Strength Requirements

Where ordinary Pozzolona Portland cement conforming to IS: 269 is used the compressive strength requirements for various grades of concrete shall be as shown in Table -2 of IS: 456 -2000 where rapid hardening Portland cement is used the 28 days compressive strength requirements specified in Table-2 shall be met in 7 days. The strength requirements specified in Table-2 as previously given shall apply to both controlled concrete and ordinary concrete. Other requirements of concrete strength as may be desired by the Engineer-in-Charge shall be in accordance with India Standard IS: 456-2000. The acceptance of strength of concrete shall be as per clause 14 "Sampling and Strength Test of Concrete" and clause 15 "Acceptance Criteria" of IS: 456-2000 subject to stipulations and/or modifications stated elsewhere in this specification. if any. Concrete work found unsuitable for acceptance shall have to be dismantled and replaced to the satisfaction of the Engineer-in-charge by the contractor free of cost to the Department. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. washed in the dismantled portion shall be made. In the course of dismantling if any damage is done to the embedded items or adjacent structures, the same shall also be made good free of charge by the contractor to the satisfaction of the Engineer-in-charge. If the water quantity has to be increased in special cases, cement also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment for the additional cement shall be made.

Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer-in-Charge, alternatively the Compacting Factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests. The limits of consistency for structures are as specified in Table 4.8 below:

Limits of Consistency (as per IS: 456) Placing Conditions	Degree of Workability	Value of Workability
Concreting of shallow sections with vibration	Very Low	20-10 seconds, vee-bee time or 0.75-0.60 compacting factor
Concreting of lightly reinforced sections with vibration	Low	10-05 seconds, vee-bee time or 0.80-0.85

* For smaller aggregate the values shall be lower.

Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour, the contractor shall obtain the approval of the Engineer-in-Charge or his representative in a "Pour Card" maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability, quantity of water per unit of cement, number of test cubes to be taken, finishing to be done, any admixture to be added, etc.

Transportation and Pouring

The concrete mixer shall be as close to the place of concreting as possible but not as close as to produce vibration and disturbance to the shuttering and reinforcements. It shall be located at such a position that time lapse for transportation of unloaded concrete mix from the mixer to the place of deposition of concrete is minimum.

When there is a difference in level between the unloading platforms of concrete from the mixer to the actual place of deposition of concrete, the concrete shall be transported manually as by means of builder's hoist / crane or concrete pump to the actual level of concreting, depending on requirement as approved by Engineer-in-charge.

Chutes for transporting the concrete shall not normally be used. The Engineer-in-Charge's written permission shall be taken for transporting by means of chutes. If use of chutes is permitted then the concrete shall be again thoroughly mixed by using spades manually before placing the concrete in the moulds / shuttering to avoid segregation of concrete. It shall be ensured that initial setting of the concrete shall not take place and the mix of the concrete is as good as that of freshly poured concrete delivered directly into the moulds/shuttering. It shall be ensured that the drop of concrete is not from an excessive height and that the vibration and deposition of concrete are simultaneously carried out. Before placing concrete, all equipment for mixing and transporting the concrete shall be cleaned and all debris shall be removed from the place to be occupied by the concrete. All form and soil surface shall be finished to desired levels and shall be thoroughly wetted immediately prior to placing of concrete. No concrete shall be placed until the Engineer-in-Charge has approved the excavation formwork and the reinforcement. The competent formwork maker and steel fixer shall be in attendance during concreting operation. The Pour card shall be signed by the contractor, designer and the representative of the consultants indicating the checking of the reinforcement, forms, and the sizes of the member to be concreted. Concrete shall be handled from the place of mixing to the place of final deposit as rapidly as practicable by methods, which shall prevent the segregation or loss of any of the ingredients. If segregation does occur during transport, the concrete shall be remixed before being placed. The concrete shall be placed and compacted before setting commences and shall not be subsequently disturbed. To ensure bond and water tightness between old concrete surface and the concrete to be placed PVC water stops of approved make and size 150 mm wide, 10 mm thick should be used. The bonding of old and new concrete shall be done by applying cement slurry after thoroughly watering the old concrete surface and removing all loose particles.

In specified cases, with approval of Engineer-in-charge the surface shall be cleaned and roughened by initial green cut by wire brushes or chipping. The initial green cutting may be done after 6 hours of placing concrete in order to facilitate the work. The old concrete walls/members shall be given a shear of 50 x 65 mm deep. This key shall also be thoroughly cleaned with wire brush in green stage before next lift pouring to avoid percolation of works.

Special methods of Concreting

If the contractor proposes to use the special methods of concreting not included in this specification, such as pumping concrete or using vacuum moulds he shall obtain the Engineer's approval before commencing work and comply with any subsequent specifications made by the Engineer for this special method of concreting. Contractor is advised to use modern techniques in adapting methods of laying/finishing concrete in raft / wall etc., eg. in raft, use of any other acceptable and proven method will be welcomed. The contractor may elaborate same on while quoting the offer. No extra payment shall be entertained for the approval of concreting by the special methods.

Placing of concrete in slabs and beams

Concrete in slabs shall be placed in one continuous operation for each span unless otherwise directed. Longitudinal construction joints, if required by reason of the width to be placed shall be located as shown on the drawings or as directed by the Engineer-in-Charge. Concrete in the stem and slab of T-beam shall be placed in one continuous operation and shall be deposited uniformly for the full length of the beam and brought up evenly in horizontal layers. Where the size of the member is such that it cannot be made in one pour, transverse vertical construction joints shall preferably be located within the area of contra flexure. For continuous spans, where required by design considerations the concrete placing sequence shall be approved by the Engineer-in-Charge.

Concreting floors

Concreting in floor shall be done in a chess board pattern, allowing sufficient time to elapse before the adjacent band is cast. The panel size is restricted to 7.5m in reinforced concrete slab. Concreting shall not be started unless the electrical conduits or any other piping Puddle Collars wherever required or laid by the concerned agency. The civil contractor shall afford all the facilities and maintain co-ordination of work with other agencies engaged in electrical and such other works as directed by the Engineer-in-Charge. Where concrete is placed on soil it shall be placed only on firm undisturbed ground. Any concrete that is placed on a well compacted fill shall have the prior approval of the Engineer-in-Charge. Concrete shall not be placed in standing water, on sub-grade or in foundation Excavation.

Compaction

Concrete during and immediately after depositing shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

- a. The vibration shall be internal unless special authorization of other methods is given by the Engineer-in-charge or as provided herein.
- b. Vibrators shall be of type and design approved by the Engineer-in-charge. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.
- c. The intensity of vibration shall be such as to visibly affect a mass of concrete of 25 mm slump over a radius of at least 0.5m
- d. The contractor shall provide a sufficiently number of vibrators to properly compact each batch immediately after it is placed in the forms.
- e. Vibrators shall be manipulated so as to have thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted into and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibration shall be at points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in forms over distances so great as to cause segregation and vibrators shall not be used to transport concrete in the forms.

Vibration shall be supplemented by Roding / spading as necessary to ensure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators. The whole process starting from the mixing of concrete to the placing and compaction shall not take more than 20 minutes and the process shall be completed before the initial setting takes place.

Curing

Curing shall be accomplished in accordance with IS: 456-2000 by keeping the concrete covered with a layer of sacking canvas, hessian or similar absorbent materials and kept constantly wet for at least ten days in continuation from the date of placing of concrete unless otherwise specified. The approval of the Engineer-in-Charge shall be obtained for the method of curing the contractor proposes to use on the work. In very hot weather precautions shall be taken to see that temperature of wet concrete does not exceed 38°C while placing. Heavy loads shall not be placed on or moved across over the floor slabs until curing is complete. Care shall be taken to prevent floor surface from being marred during curing period. Freshly laid concrete form work shall not be jarred. Concrete placed in trenches or Excavation shall be protected from falling earth during and after placing.

Consistency

The consistency of concrete shall be frequently checked by means of a slump test performed as per the relevant Indian Standard by the Engineer-in-Charge. The maximum and minimum slump for each class of concrete shall be as directed by the Engineer-in-Charge, and any concrete as represented by the slump test which fails to comply with these directions shall be removed from the site and disposal off at the contractor's cost.

Finishing Concrete

On striking the formwork, all blowholes and honeycombing observed shall be brought to the notice of Engineer-in-Charge. The Engineer-in-Charge may, at his discretion allow such honeycombing or blowholes to be rectified by necessary chippings and packing or grouting with concrete or cement mortar. If mortar is used, it shall be 1:2 mix or as specified by Engineer-in-Charge. However, if honey combing or blowholes are of such extent as being undesirable, the Engineer-in-Charge may reject the work totally and his decision shall be binding. No extra payment shall be made for rectifying these defects. All burrs and uneven faces shall be rubbed smooth with the help of carborundum stone. The surface of non-shuttered faces shall be smoothened with a wooden float to give a finish equal to that of the rubbed

down shuttered faces. Concealed concrete faces shall be left as from the shuttering except that honeycombed surface shall be made good as detailed above. The top faces of slabs not intended to be surfaced shall be leveled and floated to a smooth finish at the levels or falls shown on the drawings or elsewhere. The floating shall not be executed to the extent of bringing excess fine material to the surface.

The top faces of slabs intended to be covered with screed, granolithic or similar faces shall be left with a rough finish.

Work in Extreme Weather

During hot weather (atmospheric temperature above 40 degree centigrade) or cold weather (atmospheric temperature at 5 degree centigrade and below) the concreting shall be done as per the procedure and precautions set out in IS: 7861 (Part I and II).

Dependence shall not be placed on salt or other chemicals for the prevention of freezing. Calcium chloride shall not be used as an accelerator except with the approval of the Engineer-in-Charge. Recommendation given in relevant clauses of IS: 456 shall be strictly adhered to.

Loading of the Structures

No concrete structures shall be loaded until the concrete is at least 28 days old and only then with the approval of the Engineer-in-Charge and subject to such conditions as he may lay down.

Testing and Acceptance Criteria of Concrete

The sampling of concrete making the test specimens, curing and testing procedures etc. shall be in accordance with IS: 1199, IS: 3085 and IS: 516, the size of specimen being 15 cm cubes. Normally only compression tests shall be performed in accordance with IS: 516. For each grade of concrete and for each 8 hours of work or portion thereof the following samples shall be taken. At least six specimens shall be taken from the first 15.0 m³ or part thereof and three of these shall be tested at 7 days and the remaining at 28 days. Four additional specimens shall be taken from each additional 15.0 m³ of concrete or portion thereof of which 2 specimens shall be tested at 7 days and the remaining at 28 days. To control the consistency of concrete from every mixing plant slump test, and/or compacting factor tests in accordance with IS: 1199 shall be carried out by the contractor every two hours or as directed by the Engineer-in-Charge. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456-2000. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specifications by the contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement embedded fixtures etc. shall be paid. In the course of dismantling if any damage is done to, the embedded items or adjacent structures the same shall be made good free of charge by the contractor to the satisfaction of the Engineer-in-Charge.

Load Test of Structures

The Engineer-in-Charge may instruct for a load test to be carried out on any structure if in his opinion such a test is deemed necessary for any of the following reasons. The works site made concrete test-cube failing to attain the specified strength, as per the criteria laid down in IS: 456-2000. Suspected overloading during construction of the structure under

review shuttering being prematurely removed and not as per the specification the concrete is being improperly cured. Visible deficiencies of the concrete if the results of the load test be unsatisfactory, the Engineer-in-Charge may instruct the Contractor to demolish and reconstruct the structure or part thereof at the contractor's cost. The load test of structures shall be carried out as per the clause 16.5 of IS: 456-2000.

Special methods of concreting

The contractor should propose to use special methods of concreting not included in the specifications, such as pumping concrete or using vacuum moulds, he shall obtain the Engineer-in-Charge's approval before commencing work and comply with any subsequent specification made by the Engineer-in-Charge for this special method of concreting. Contractor is advised to use modern techniques in adopting methods of laying / finishing concrete in raft / walls etc. e.g. in raft use of any other acceptable and proven method will be welcomed. The contractor may elaborate same on while quoting the offer.

Codes and Standards

All applicable standards, specifications, etc. and codes of practice shall generally be the latest editions, including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the contractor. All work shall be carried out as per the stipulations contained in various sections of these specifications and the latest Indian Standards, Acts, Codes and best practices. In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian Standard, Codes, etc. the requirements of stipulations contained in various sections of these specifications, shall prevail over that of Indian Standards, Codes, etc.

Some of the applicable Indian Standard Codes, etc. are referred here below;

IS: 73	Specification for paving bitumen
IS: 2060	Specification for structural steel
IS: 8112	Specification for ordinary Portland cement 43 grade.
IS: 280	Specification for mild steel wire for general engineering purposes
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 432 (Part I & II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS: 455	Specification for Portland Slag Cement
IS: 456	Code of practice for plain and reinforced concrete
IS: 457	Code of Practice for general construction of plain & reinforced concrete for dams and other massive structure
IS: 516	Method of test for strength of Concrete
IS: 650	Specification for standard sand for testing of cement
IS: 702	Specification for industrial bitumen
IS: 816	Code of practice for use of metal as welding for general construction in mild steel

IS: 1199	Methods of sampling and analysis of concrete
IS: 1200 (Part II, V, VIII, XVIII, SVIII)	Method of measurement of building and civil engineering works, water proofing and damp proofing
IS: 1367	Technical supply conditions for threaded steel fasteners
IS: 1489	Specification for Portland pozzolona cement (Part I) Fly ash based & (Part II) Calcite clay based
IS: 1566	Specification for Hard drawn steel wire fabric for concrete reinforcement
IS: 1609	Code of practice for laying damp proof treatment. Using bitumen felts.
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1791	General requirements for batch type concrete mixer.
IS: 1838	Specification for performed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type)
IS: 2204	Code of practice for construction of reinforced concrete shell roof
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plate
IS: 2386 (Part I to VIII)	Methods for test of aggregates for concrete
IS: 2438	Specification for roller pan mixer
IS: 2502	Code of practice of bending and fixing of bars for concrete reinforcement
IS: 2505	General requirements for concrete vibrators, immersion type
IS: 2506	General requirements for concrete vibrators, screen board type
IS: 2514	Specification for concrete vibrating tables
IS: 2571	Code of practice for laying in situ cement concrete flooring
IS: 2645	Specification for integral cement water proofing compounds
IS: 2722	Specification for portable swing weigh batchers for concrete (single and double bucket type)
IS: 2750	Specification for steel scaffoldings
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction
IS: 3025	Methods of sampling and test waste water
IS: 3067	Code of practice for general design details and preparatory work for damp proofing & water proofing of buildings
IS: 3150	Specification for hexagonal wire netting for general purposes
IS: 3366	Specification for pan vibrators
IS: 3370 (Part I & II)	Code of practice for concrete structures for the storage of liquids
IS: 3384	Specification for bitumen primer for use in water proofing & damp proofing
IS: 3414	Code of practice for design and installation of joints in buildings

IS: 3550	Methods of test for routine control for water used in industry
IS: 3558	Code of practice for use in immersion vibrators for consolidating concrete
IS: 3696 (Part I & II)	Safety code for scaffolds and ladders
IS: 4014 (Part I & II)	Code of practice for steel tubular scaffolding
IS: 4031	Methods for physical tests for hydraulic cement
IS: 4130	Safety code for demolition of buildings.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings
IS: 4461	Code of practice for joints in surface hydroelectric power stations
IS: 4356	Specification for form vibrators for concrete
IS: 4925	Specification for batching and mixing plant
IS: 4990	Specification for plywood for concrete shuttering work
IS: 4995 (Part I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials
IS: 5121	Safety code for piling and other deep foundations
IS: 5256	Code of practice for sealing joints in concrete lining on canals
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work
IS: 5624	Specification for foundation bolts
IS: 6461	Glossary of terms relating to cement concrete
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools
IS: 6509	Code of practice for installation of joints in concrete payments
IS: 7193	Specification for glass fiber base coal tar pitch and bitumen felts
IS: 7293	Safety code for working with construction machinery
IS: 7861 (Part I & II)	Code of practice for extreme weather concreting
IS: 9012	Recommended practice for shuttering
IS: 9103	Specification for admixtures for concrete
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 9595	Recommendations for metal-arc welding of carbon and carbon manganese steels
IS: 10262	Recommended guidelines for concrete mix design Code of practice for composite construction in structural steel and concrete
IS: 11984	Specification for two parts polysulphides.
IS: 12118	Code of practice for provision of water slops at transverse contraction joints in masonry and concrete dams
IS: 122000	53 grade ordinary Portland cement
IS: 12269	Portland cement, low heat

IS: 23	Handbook of concrete mixes
IS: 24	Explanatory Handbook on IS:456-1978
IS: 34	Handbook on concrete reinforcement and Detailing.

Item No.4: - Providing and fixing in position steel bar reinforcement of various diameters for RCC piles, caps, footings, foundations, slabs, beams, columns, canopies, staircases, newels, chajjas, lintels, pardies, copings, fins, arches, etc. as per detailed designs, drawings and schedules; including cutting, bending, hooking the bars, binding with wires or tack welding and supporting as required, etc. complete (including cost of binding wire). (Bd-F-17/306).

The item provides for supply of mild steel, tor steel bars, cutting, bending with G.I. wire and placing in position, welding for reinforcement in the RCC.

Mild steel and tor steel bars shall confirm to Specification A-10 of Standard Specification of Public Works Department, Latest Edition.

The binding wire shall confirm to Specification A-15 of Standard Specification of Public Works Department, Latest Edition.

During contractor's supply, if any, the steel bars shall be supplied directly to the site of work.

Bending reinforcement confirm accurately to the dimensions and shapes in the details drawings (approved) or as directed by the Engineer-in-charge.

- a) Bars shall be bend cold only. In no way bending by heat will be allowed.
- b) Bars with kinks, bends or cracks shall not be used.
- c) Details of length, size, laps and bending diagram shall be got approved by the Engineer-in-charge.

As far as possible full length of bars shall be placed as per drawing details. When full lengths are not available, bars be supplies only after written permission of the Engineer-in-charge. Supplies shall be staggered and in tension zone shall be avoided strictly. Bars shall be lapped as specified in IS:456-2000 with due regards to the grade of concrete. Welding may be used for large diameter of bar only after permission of Engineer-in-charge.

Welding, if permitted shall conform to specification B.10.7 of Standard Specification of Public Works Department.

All reinforcement shall be accurately placed in position with spacing and cover shown in detailed drawing and firmly held during the placing and setting of concrete. Bars shall be ties at all intersections. Binding wire of 1.63 mm or 1.22 mm diameter (about 16 or 18 gauge) shall be used. Spacing of the bars shall be maintained by means of stays, blocks ties, spacers, hangers or other approved supports at sufficient close intervals so that bars will not be displaced. During placing vibrating or compacting concrete, placing bars for reinforcement on a layer of fresh concrete as the work progress will not be permitted. The use of pieces of broken stones or bricks or wooden blocks for maintaining spacing or cover shall not be permitted. Layers of bars shall be separated by precast cement blocks, spacer bars or other devices.

Full details of numbers, sizes, lengths, weights, laps, welds, spacing of bars placed in position in different parts of the work shall be recorded by the contractor and certified and signed by the Engineer-in-charge or his representative to show that all reinforcement has been placed correctly as per sanctioned drawing or as directed by the Engineer -in-charge in writing, before placing concrete. No concrete shall be placed in position until the certified the correctness of reinforcement, recording the steel measurements and has given permission in writing to place concrete. After approval of reinforcement as above, it will be the contractor's responsibility to seal that the spacing of reinforcement and arrangements are not tampered with in any way before or during concreting.

Any steel is required to be procured by Contractor. He shall produce the test certificate. In addition, actual test shall be carried out according to IS:432-1982, in a Government laboratory and the cost of test shall be borne by the contractor, including all transport, etc.

This item includes,

- a) Cost of labour, materials, use of tools, plant and tackle and other incidental items to complete the work satisfactorily.
- b) Supplying, conveying, cleaning, cutting, bending, binding with (1.63 mm or 1.22 mm diameter – 16 to 18 gauge) wire on spot, welding and placing reinforcement in position and maintaining it clean and in position till the concrete is laid.
- c) Cost of sampling and testing, as required.

In no case, any foreign material e.g., oil, grease, etc. which prevent bonding between steel and concrete shall remain on steel-on-steel bars during placing of concrete.

MODE OF MEASUREMENT AND PAYMENT

The tender rate shall be on weight basis for MT of MS / tor steel reinforcement. The weight of steel reinforcement used for the item of concrete will be measured in tonnes based on total compacted weight for the sizes and lengths of bars as shown in drawing or as directed by Engineer-in-charge.

The lengths of the bars shall be measured correct to 2 places of decimals of meters. The weights for payments shall be calculated according to standard weights mentioned in the ISI Hand Book correct up to 0.10 Kg.

Item No.5: - Providing second class Burnt Brick masonry with conventional/ I.S. type bricks in cement mortar 1:6 in superstructure including striking joints, raking out joints, watering and scaffolding etc. Complete.

This shall be done as per standard specification No. Bd-G-1 & 5 on Page no. 313 & 315 respectively. This item includes brick masonry in C.M. 1:6 for Plinth, super structure and steps. Steps up to plinth level of 1m width including P.C.C. M-150 grade and 100mm. thick, below base of steps, also 20mm plastering Both faces and cement concrete flooring over the steps. The thickness of joints in brick work shall be 12mm for conventional bricks and 10 mm for I.S. type bricks. The bricks shall be used for above work including Transportation, loading, unloading, stacking properly at the site of work at the cost of Contractor and shall be got approved by Engineer-in-charge. The representative Samples as per recent circular of M.J.P. shall be tested for various test in the laboratory of Government Engineering College at the cost of contractor.

Brick masonry

General

All bricks shall be of class designation 10 or best locally available approved by Engineer-in-Charge made of good brick earth thoroughly burnt, and shall be of deep cherry red or copper color. Bricks shall be regular in shape and their edges shall be sharp and shall emit clear ringing sound on being struck and shall be free from cracks, chips, flaws and lumps of any kind. Bricks shall not absorb water more than one sixth. of their weight after one hour of soaking by immersing the water. Bricks shall have a minimum crushing strength of 105 kg/cm² (10.5 N/mm²). Bricks shall be fully soaked in clean water by submerging in a tank for a period of 12 hours immediately before use. Soaking shall be continued till air bubbling is ceased. Bricks shall be well bonded and laid in English bond unless otherwise specified. Every course shall be truly horizontal and wall shall be truly in plumb. Vertical joints of consecutive course shall not come directly over one another; vertical joints in alternate course shall come directly over one another. No damaged or broken bricks shall be used. Closers shall be of clean-cut bricks and shall be placed near the ends of walls but not at the other edge. Selected best-shaped bricks shall be used for face work. Mortar joints shall not exceed 6 mm in thickness and joints shall be fully filled with mortar. Bricks shall be laid with frogs upwards except in the top course where frogs shall be placed downward. Brickwork shall be carried out not more than 1.2m height at a time. When one part of the wall has to be delayed, stepping shall be left at an angle of 45°. Corbelling or projections, where made shall not be more, than X brick projections in one course. All joints shall be raked and faces of wall cleaned at the end of each day's work. These specifications deal with all types of brickwork required for buildings, manholes, drains, retaining walls or any construction made out of bricks.

Materials

Bricks

Bricks used for the construction of brick masonry shall be hard, rectangular in shape and size and well burnt of uniform deep red, cherry or copper color and shall confirm to IS: 1077-1986. The brick shall not break when it falls down from 1.0 m height above the ground. Over burnt and the under burnt bricks will not be accepted. It should give the ringing sound when struck up with the hard material. The bricks shall be brought from approved brick kilns. The bricks shall be free from cracks, chippings, flaws, stones or lumps of any kind. The bricks shall not show any signs of efflorescence and shall be homogeneous in texture. They shall emit a clear metallic ringing sound on being struck and shall have a minimum compressive strength of 10.5 N/mm² equivalent to 105 kg/cm². They shall not absorb more than 20% of its dry weight when soaked in cold water for 24 hours or otherwise specified in the Indian Standard Specification.

Mortar

The proportion of the cement mortar used for the masonry work shall be as specified on the various drawings for different places/types of construction, specifications for each part of the work. For cement mortar fresh Portland cement of standard specifications shall be used. Sand shall be sharp, clean and free from organic and foreign matters. For rich mortar coarse or medium sand shall be used and for weak mortar local fine sand may be used. Materials of mortar shall be measured to have the required proportion with measuring box and first mixed dry to have a uniform color in a dean masonry platform and then mixed by adding clean water slowly and gradually to have workable consistency and mixed thoroughly by turning at least three times. Fresh mixed mortar shall be used, old and stale

mortar shall not be used and mortar for an hour work only shall be mixed with water so that the mortar may be used before setting starts. Coarse sand is mixed with the required quantity of cement for the preparation of the mortar. Mortar shall be prepared in accordance with IS: 2250-1981. The sand used for the masonry mortar shall meet the requirements as specified in IS: 2116-1980. For masonry mortars, sand and cement of required proportions are mixed in small quantities in a dry state first and then water is added to make the mortar of required consistency suitable for the type of work for which it is required as directed by the Engineer-in-Charge. No left-over mortar shall be used and therefore only that much quantity of mortar that can be consumed within 30 minutes shall be mixed in batches.

Table: Grading of sand for use in Masonry Mortar

IS Sieve Designation	Percentage passing by mass
4.75 mm	100
2.36 mm	90 to 100
1.18 mm	70 to 100
600 micron	40 to 100
300 micron	5 to 70
150 micron	0 to 15

Construction

The brick masonry shall be constructed as per the Indian Standard Code of Practice for Brick Work IS: 2212- 1962. The thickness of the joints shall not be thicker than those specified in Para 5.4 of the above Code of Practice. The bricks shall be thoroughly soaked in water before using them on the work for at least twelve hours and all the air bubbles shall come out during soaking process. The soaked bricks shall be stacked on wooden planks/platforms so as to avoid sticking of the earth and other materials on to the surfaces of bricks. Bricks required for construction in mud mortar or lime mortar shall not be soaked. Brickwork shall be laid in English Bond unless otherwise specified. Half bricks shall not be used except when needed to complete the bond. Each course shall be perfectly straight and horizontal. The masonry shall be true to plumb in case of vertical walls and in case of battered construction the batter or slope shall be truly maintained. The level of the courses completed shall be checked at every one-meter interval or less as required. While constructing the brick work one side shall be in plumb as directed by the Engineer in Charge.

The bricks shall be laid frogs upwards. While laying the bricks they shall be thoroughly bedded and flushed in mortar and well tapped into position with wooden mallets and superfluous mortar shall be removed. No part of the structure shall be raised more than one meter above than the rest of the work. In case it is unavoidable the brickwork shall be raked back at an angle of not more than 45 degrees so as to maintain a uniform and effectual bond, but raking shall not start within 60 cms from a corner. In case of construction of buttresses, counter forts, returns they are built course by course carefully bound into the main walls. At all junctions of walls, the bricks at alternate courses, shall be carried into each of the respective walls so as to thoroughly unite both the walls together. The brickwork shall not be raised more than 14 courses per day. All the beds and joints shall be normal to the pressures applied upon them Le horizontal in vertical walls, radial in arches and at right angles to the face in battered retaining walls. Vertical joints in alternate

courses shall come directly one over the other and shall be truly vertical. Care shall be taken to ensure that all the joints are fully fitted up with mortar, well flushed up where no pointing is proposed, nearly struck as the work proceeds. The joints in faces which are plastered or painted shall be squarely raked out to a depth not less than 12 mm while the mortar is still green. The raked joints shall be well brushed to remove the loose particles and the surfaces shall be cleaned with a wire brush so as to remove any splashes of mortar sticking to the surfaces during the construction. All iron fixtures, pipes, bolts, conduits, sleeves, holdfasts etc. which are required to build into the walls shall be embedded in cement mortar or cement concrete as shown in the drawings/indicated in the specifications/directed during the execution by the Engineer in-Charge as the work proceeds and no holes be left for fixing them at a later date unless authorized by the Engineer-in-Charge.

Curing

Green work shall be protected from rain by covering the work suitably. Masonry work as it progresses shall be thoroughly kept wet by watering on all the faces for at least 10 (Ten) days in continuation after completion of the parts of the work. Proper watering cans, flexible pipes, nozzles shall be used for the purpose in case of fat lime mortar curing shall start two days after construction of masonry and shall continue for seven days. No additional payment is admissible for curing and the rates quoted are deemed to be inclusive of the cost of curing.

Scaffolding

Double scaffolding sufficiently strong so as to withstand all loads that are likely to come upon it and having two sets of vertical supports shall be provided. Where two sets of vertical supports are not possible the inner end of the horizontal supporting pole shall rest in a hole provided in a header course only. Only one header for each pole shall be left out. Such holes however shall not be permitted in pillars less one meter in width or immediately near the skew backs of arches. Such holes shall be filled up immediately after removal of the scaffoldings. Safety Code for Scaffoldings and Ladders, IS: 3696-1987 (Parts I and II) shall be followed.

Mode of Measurement:

The contract rate shall be for a unit of one cubic meter of Masonry. The concrete shall be measured for its length, breadth and depth limiting dimensions to those specified on the plan or as directed by Engineer-in-Charge. No deduction shall be made for reinforcement in concrete in RCC work. Individual dimension shall be measured in Cum. And quantities shall be worked out correct up to three places of decimal of a cubic meter.

Item No.6: -Providing internal cement plaster 12mm thick in single coat in cement mortar 1:3 without neeru finish to concrete or brick surfaces, in all position including scaffolding and curing etc. complete. Bd.L.2 Page Number 368.

This shall be done as per standard specification No. Bd-L-5-page No.368. The item shall comply with specification B.11.b subject to the additional clauses Bd.L 1.2, Bd.L 1.3, Bd.L 1.4

- i) 20mm thick cement plaster in C.M.1:2 with water proofing (Wet well) shall be provided to innerface of vertical wall of sump (Wet well) & pump house (dry well) and screen chamber.
- ii) 20mm thick cement plaster in C.M. 1:3 shall be provided to external Face of brick work to pump house.

iii) 12mm thick cement plaster in C.M. 1:3 shall be provided to internal Faces of brick work to pump house, external face of screen chamber, wet well and dry landings (bottom portion), waist slab ceiling and sides, roof slab ceiling etc.

All above plaster shall be done in Sulphate Resistant Cement Only Number of cubes for Cement mortar shall be taken as per I.S. and recent circular of M.J.P. and shall be tested in the laboratory of Government Engineering College at the cost of contractor. Certificate of testing shall be submitted by the contractor to the department. Cement mortar used for plastering shall be of the mix proportions and thickness as specified on the drawings or bill of quantities or particular specifications for the various different parts of the works. The materials used i.e., cement, sand and water shall be of the same quality and of the same specifications as indicated for plain and reinforced cement concrete works according to the specifications and approved by the Engineer-in-Charge. Sand further shall meet the specifications as laid down in IS: 1542-1977 Specification for sand for plaster.

The sand for preparation of mortar for plastering shall confirm to the following gradation, shown in Table
Table: Grading of fine aggregates Percentage by weight passing IS Sieve

IS Sieve Designation	Class -A	Class-B
4.75 mm	100	100
2.36 mm	90 to 100	90 to 100
1.18 mm	70 to 100	70 to 100
600 Microns	40 to 85	40 to 95
300 Microns	50 to 50	10 to 65
150 Microns	0 to 10	0 to 15

For the purpose of indicating the suitability for use, the sand is classified as Class A and Class B in accordance with the limits of grading. Class A sand shall be used generally for plastering and when they are not available, Class B sand may be used with the approval of Engineer-in-Charge.

The procurement of sand for Mortar for plastering and pointing shall confirm to be specifications given in Table. Surface that are to be applied with plaster shall be thoroughly cleaned to remove dust, dirt, loose particle, oil, soil, salts etc., that may be sticking to the surfaces. The surfaces shall be washed, clean and watered properly for 4 hours before applying plaster. For masonry all joints in the frame work that is to be plastered shall be raked out to a depth not less than the width of the joints or as directed by the Engineer-in-charge. The raking shall be done taking care not to allow any chipping of masonry. In new work the raking out shall be done while the mortar in the joints is still green. Smooth surface of concrete or plaster etc. must be suitably roughened to provide necessary bond for the plaster all dirt, soot oil paint or any other materials that might interfere with satisfactory bond shall remove and surface wetted before plastering is started. Plaster shall not, in any case, be thinner than specified. It shall have uniform specified thickness. When smooth finishing is required the cement plastering shall be floated over with neat cement within 15 minutes after application of the last coat of plastering. The plaster shall be protected from the sun and rain by such means as the Engineer-in-Charge may approve.

The plastered surface shall be cured for 10 (ten) days. Construction joints in plastering shall be kept at places approved by the Engineer-in-charge. When the thickness of the plaster specified is to be made up in more than one layer the second layer shall be applied only when the lower coat is still green. Wherever specified approved brands of additives like water proofing compounds, shall be added in specified quantities as recommended by the manufacturer of the compound or as directed by the Engineer-in-Charge.

Wherever scaffolds are necessary for plastering they shall be provided as specified for scaffolds under clause 3.2.2. Stage scaffolding shall be provided for ceiling plaster. To ensure even thickness and true surface, patches of plaster about 15 cm x 15 cm shall be first applied both horizontally and vertically 2.0 m apart. Plastering shall be done. From top of bottom and care shall be taken to avoid joints on continuous surface. In case any other finish like rough cast finish or dry dash finish is specified in the drawings the same shall be provided as directed by the Engineer-in-Charge. Surface which is to be plastered shall be roughened while they are still green or raked so as to give proper bond between the surface and plaster. When cement finish is specified, coat of pure Portland cement slurry 1.5 mm (1/6') thick shall be applied to the plastered surface while the second coat is still fresh. If neeru finish is specified, then the surface shall be finished as per specification for Item Bd. L-10.

All corners' junctions shall be truly vertical or horizontal as the case may be and carefully finished. Rounding or chamfering of corners shall be carried out with proper templates to the required size and shapes. The work shall be tested frequently with a straight edge and plumb bob. At the end of the day the plaster shall be left cut clean to line. When the next days plastering is started, the day the plaster shall be left cut clean to line. When the next days plastering is started the edge of the old work shall be scrapped, cleaned and wetted with cement slurry. At the end of the day the plastering shall be closed on the body of the wall and not nearer than 15 cm to any corner. Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for at least 10 days. Any defective plaster shall be cut in rectangular shape and replaced. The thickness of the cement plaster shall be 12 mm excluding cement or neeru finish.

Mode of measurement

as per NdL-1.7 on square meter basis

MATERIALS

Cement mortar shall be prepared from cement and as specified for RCC work and mixed in the proportion specified. Sand shall be screened and washed if called upon to do so. Water proofing compound of directed make in directed quantities shall be added where it is water proof plaster, scaffolding shall be prepared from sound materials and shall be provided, where ever situation demands for facility of proper working.

GAUGES

Patch of plaster 15 x 15 cm shall be put on about 3 m apart as gauges to ensure even plastering in one place.

FINISHING

In any continuous face of wall, finishing treatment of any type shall be carried out continuously and day to day breaks made to coincide with architectural breaks in order to avoid unsightly junctions. All mouldings

shall be worked true to template and drawn neat, clean and level. All exposed angles, junctions and openings shall be carefully finished.

WATERING

All pointing work shall be kept damp continuously for a period of 14 days. To prevent excessive evaporation of the sunny and wind ward side of the building in hot, dry weather matting or gunny bags may be hung over on the outside of the plaster in the beginning and kept moist. If the contractor fails to water the work to the satisfaction of the Engineer-in-charge, the requisite labour, materials and equipment to water the work properly shall be engaged departmentally at the cost of the contractor. Cost all scaffolding is included in the tender rate.

Item No.7: -Providing sand faced plaster externally in cement mortar using approved screened sand, in all positions including base coat of 15 mm thick in cement mortar 1:4 using waterproofing compound at 1 kg per cement bag curing the same for not less than 2 days and keeping the surface of the base coat rough to receive the sand faced treatment 6 to 8 mm thick in cement mortar 1:4 finishing the surface by taking out grains and curing for fourteen days scaffolding etc. complete.

SAND FACED CEMENT PLASTER

GENERAL

The item shall comply with the specification B.11 in all pertinent particulars. In addition Bd.L.1.2, Bd.L 1.3, Bd.L 1.4 and the following specifications shall also be complied with.

Base Coat: The base coat plaster shall be of cement mortar 1:4. Water proofing compound of approved make like Pudlo, Sika, Accorproof shall be added according to the maker's instruction in Bd.L 2 which a thickness of 15 mm for brick work and concrete surfaces and 20 mm for rubble stone masonry. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still plastic.

Sand Faced Treatment:

The cement mortar for sand faced plaster shall have washed Kharsalia or Kasaba or similar type of approved sand with slightly larger proportion of coarse material the proportion of cement to sand shall be 1:4. The water is added gradually to make the mixture homogeneous. The thickness of finishing coat shall not exceed 8 mm. After applications the surface should be finished with a wooden float lined with cork and tapped gently to retain a coarse surface texture. When the finishing coat has hardened the surface shall be kept moist continuously for 14 days.

Item to include relevant portion of Bd.L 1.6. it shall also be including the base coat and san face treatment of above.

Mode of Measurement and payment

As per Bd. L 1.7 on square meter basis

The specification lays down the requirements of applying sand faced plaster in specified thickness with cement mortar to concrete or masonry surface in specified coats. This shall conform to specification for ordinary cement plaster where ever it is not irrelevant and in addition following shall also be applicable.

Tools and accessories used in plastering work be thoroughly cleaned before plastering is done. The programming of other building operations before during and after plastering shall be according to the instructions contained in Clause

4 of IS:1661-1960 or its latest revision. The item shall be executed as per Red book specification BdL-7-to-7.50-page No. 351)

Care shall be taken that other parts of work of adjacent work are not damaged while plastering. The base coat plaster shall be of cement mortar of specified proportion 1:4 and thickness as mentioned in the item or otherwise, it shall be of cement mortar 1:3 and thickness 15 mm to 20 mm. The base coat shall be laid in a similar manner as stipulated in. However, instead of finishing the top surface smooth keys shall be formed on the surface thoroughly combined in with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still plastic. The base coat shall be cured for suitable period as per relevant code.

Item No.8: -Providing Neeru finish to plastered surfaces in all positions including scaffolding and curing etc. complete.

Specification as per Sub Work No- 4 Item No. 6

Item No.9: -Providing and fixing in position. (as per I.S.1868 / 1982) Aluminium sliding window of two tracks with rectangular pipe having overall dimension 63.50 x 38.10 x 1.02 mm at weight 0.547 kg/Rmt. and window frame bottom track section 61.85 x 31.75 x 1.20 mm at weight 0.695 kg/Rmt. Top and side track section 61.85 x 31.75 x 1.30 mm at weight 0.659 g/Rmt. The shutter should be of bearing bottom 40 x 18 x 1.25 mm at weight 0.417 kg/Rmt. Inter locking section 40 x 18 x 1.10 mm at weight 0.469 kg/Rmt. And handle section 40 x 18 x 1.25 mm at weight 0.417 kg/Rmt. and top section 40 x 18 x 1.25 mm at weight 0.417 kg/Rmt. As per detailed drawings and as directed by Engineer in charge with all necessary Aluminium sections fixtures and fastenings such as roller bearing in nylon casting and self-locking catch fitted in vertical section of shutter including 5 mm thick plain glass with all required screws and nuts etc, complete. With colour Anodising with box.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer-in-charge.

Mode of Payment: -

The item shall be measured and paid on square meter basis.

Item No.10: -Providing and fixing rolling shutter fabricated from steel laths of minimum thickness 0.9 mm with lock plate of 3.15 mm thickness reinforced with 35 x 35 x 5 mm angle section fitted with sliding bolts and handles for both sides, deep M.S. channel section of depth and thickness not less than 65 mm and 3.15 mm respectively with hold fast arrangements, M.S. Bracket plate 300 x 300 x 3.15 mm minimum size and shape with square bar, suspension shaft of minimum 32 mm diameter, hood cover of M.S. sheet not less than 0.9 mm thickness and of any size at top and safety devices including mechanical gear operation arrangement consisting of worm gear wheels and worms of high grade cast iron or mild steel and one coat of red lead primer etc. complete. (I.S. 6248:1979) (With mechanical gear) Spec. No.: Bd.T.55 Page No. 510

This shall be done as per standard specification No. Bd-T-56 pageNo.511 and relevant item of schedule 'B'. The specifications lay down requirements of providing and fixing steel rolling shutters with accessories locking arrangement top hood cover and painting in three coats of synthetic enamel paint of approved quality and shade.

MATERIALS

The rolling shutters shall conform to IS: 6248:1979. Rolling shutter shall be supplied of specified type with accessories Such as top cover (in or out)] handles, bearings, springs, axles, locking arrangements, guide rails, iron pulleys push and pull arrangements This shall be of approved quality, make and type, 10 gauge (MS solid laths or grill) The size of the rolling shutters shall be as specified in the drawings The shutters shall be constructed with interlocking lathe sections foamed from cold rolled steel strips not less than 0.9 mm thick and 80 mm wide for shutters upto 3.5 m width and not less than 1.25 mm thick and 80 mm wide for shutters 3.5 m width and above unless otherwise specified. Guide channels shall be of mild steel deep channel section and or rolled pressed or built up (fabricated) jointless construction. The thickness of sheet used shall not be less than 3.15 mm. Head cover shall be made of M.S. sheet not less than 0.9 mm thick for shutters up to 3.5 m width. For shutters having width 3.5 mm and above the thickness of M.S. sheet for the hood cover shall not be less than 1.25 mm. The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong M.S. or Malleable C.I. brackets the brackets shall be fixed on or under the lintel as specified with raw plugs and screws bolts etc. Both the side guides and bottom rail shall be joint less and of shaft, spring etc. shall be of same material as that of lathe. The side guides fixed with plates welded to guides shall be property fixed with screws, bolts and concealed in plaster.

The rolling shutters shall be self-rolling type up to 8 Sq.mt clear area without ball bearing and up to 12 Sqm. Clear area with ball bearing. If the rolling shutters are of larger size, then gear operated type shutters shall be used. The locking arrangement shall be provided at the bottom of shutters at bottom ends. The shutters shall be opened from outside. The shutter shall be either push and pull type as operated with special type of reduction / bevel arrangement operated with mechanical device. Shutter up to 10.20 - sqm. Or outside width less than 3 m shall be push and pull and shutter above 10.20 sq. m. or whose width is more than 3 m will be mechanically operated.

The shutters shall be complete with door suspension shafts, locking arrangements, pulling hooks, handleless and other accessories.

WORKMANSHIP

Rolling shutters and top hood with all accessories shall be supplied of specified type and shall be got approved before fixing by the Engineer-in-Charge. The fixing shall be done in true line and level. The damaged work shall be made good to the level of original works. The fixing work shall be done to the entire satisfaction of the Engineer-in-Charge. After the erection and fixing, the rolling shutters with hood should be painted with on coat of approved primer and two coats of approved enamel paint (or any other approved superior quality paint as needed for protection against environment prevailing in the area)

MODE OF MEASUREMENT AND PAYMENT

The item shall include –

- a) Providing and fixing the rolling shutters of specified size, material with all accessories, locking arrangement and top hood cover.
- b) Painting the same with approved synthetic enamel paint in three coats.

c) Redoing the damaged works

The item shall be measured and paid on Square meter basis.

Item No.11: -Providing and fixing mild steel grill work for windows, ventilators etc. 20 kg/sqm as per drawing including fixtures, necessary welding and painting with one coats of anticorrosive paint and two coats of oil painting complete.

This shall be done as per standard specification & Schedule 'B' & as directed by Engineer-in-charge Mode of Measurement & Payment This item will be measured and paid in Sqm basis

Item No.12: -Providing and fixing steel ventilator fully glazed partly fixed as per detailed drawing without hot dip zinc coating including fabricating glazing with plain / obscured glass panes 5 mm thick and approved type and quality and iron oxidized fixtures and fastening oil paint 2 coats etc. complete.

This item is to be executed as per Standard Specification and as directed by Engineer-in-Charge. (The item shall be executed as per Red book Specification, Spec. No.: - Bd-T-53 Page No. 509 as Directed by Engineer in charge)

Measurement & Payment This item will be measured and paid in Sqm basis.

Item No.13: -Providing and applying three coats of water proof cement paint of approved manufacture and of approved colour to new plastered surfaces including scaffolding if necessary, cleaning and preparing the surface, watering for two days etc. complete.

GENERAL

This specification lays down the requirement of applying cement-based paint in specified coats to concrete or masonry surface.

MATERIALS

Cement paint with a base of white Portland cement of approved manufacture. Colour and shade shall be used. Approved quality cement-based paint shall be brought to site in original air tight containers with seal intact. Scaffolding wherever necessary shall be provided to the entire satisfaction of the Engineer-in-Charge.

PREPARATION

The surface to be painted shall be cleaned of all loose dust, and dirt paints and all cracks, holes and surface defects shall be repaired with cement plaster cured and allowed to set hard. Before the painting is commenced the surface is wetted well and water is allowed to run off. Any grease, oil paint, shall be removed by approved methods.

APPLICATION OF PAINT

Mixing of paint and procedure of painting shall be as specified by the manufacturer when no specification are following specification shall generally apply.

The dry cement shall be thoroughly mixed with clean fresh water to produce paint of required consistency (normally that of ordinary paints). The paint shall be kept stirred and used within one hour of mixing hardened or damaged paint shall not be used. The paint shall be applied by brushes in the manner specified by the manufacturer.

The number of coats shall be specified in the wording of the item. When more than one coat is to be given the subsequent coats shall be applied after the preceding coat has thoroughly hardened, inspected and approved.

CURING

Each application of paint should be wetted at the end of the day with a fine water spray, depending on climatic conditions. Wetting shall be done only after an interval of at least 6 to 8 hours after the applications. In dry weather the painted surfaces shall be kept damp for at least two days and protected from direct sun.

MODE OF MEASUREMENT AND PAYMENT

The item includes,

- a) All materials and labour for painting.
- b) All equipment and scaffolding.
- c) Curing as per specification
- d) Non uniform colour or shade shall be rectified without any extra cost.

The item shall measure and paid in per Sqmt basis of area painted.

Item No.14: -Providing and applying washable oil-bound distemper of approved colour and shade to old and new surfaces in two coats including scaffolding, preparing the surfaces. (excluding the primer coat.) etc. complete.

Oil emulsion (Oil Bound) washable distemper (IS: 428:1969428) of approved brand and manufacture shall be used. The primer, where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared. The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and owner.

Preparation of the Surface.

For new work the surface shall be thoroughly cleaned of dust, old white or color wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any evenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry. In the case of old work, All loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc. Pitting in plaster shall be made good with plaster of Paris mixed with the color to be used. The surface shall then be rubbed

down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat:

The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described.

Note: If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat alkali resistant priming Paint conforming to IS 109 and allowed to dry for at least 48 hours before distempering is commenced. For old work no primer coat is necessary.

Cement Primer coat

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalis present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints. Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

Preparation of the Surface

The surface shall be thoroughly cleaned of dust, old white or color wash by washing and scrubbing and all cracks, holes and surface defects shall be repaired with gypsum and allowed to set hard.. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered smooth and wiped clean to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry. The surface so prepared must be completely dry and free from dust before distempering is commenced. In the case of walls newly plastered, special care shall be taken to see that it is completely dry before any treatment is attempted.

Application

The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied. The Specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under.

Distemper Coat:

For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat. For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each day's work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

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The specifications in respect of scaffolding, protective measures and measurements shall be as described under Rate. The rate shall include the cost of all labor and materials involved in all the above operations (including priming coat) described above. The rate shall include all labour, material, equipments and tools for carrying out the following operations.

- Providing the primer and distemper and mixing the distemper.
- Scaffolding
- Preparing the surface to receive the primer and finishing coats.
- Applying the priming coat
- Applying the distemper as specified above in the number of coats, mentioned in the item.

Mode of Measurement & Payment

This item will be measured and paid in Sqm basis.

Item No.15: -Providing and laying machine cut machine Polished Kota stone flooring 25mm to 30mm thick and required width in plain/ diamond pattern on bed of 1:6 C. M. including cement float, filling joints with neat cement slurry, curing, polishing and cleaning etc. complete.

This shall be done as per standard specification & Schedule 'B' & as directed by Engineer-in-charge

Mode of Measurement & Payment

This item will be measured and paid in sq m basis.

Item No.16: -Providing structural steel work in rolled stanchions fixed with connecting plates or angle cleats as in main and cross beams, hip and jack rafters, purlins connecting to truss members and like as per detailed designs and drawings or as directed by Engineer-in-charge including cutting, fabricating, hoisting, erecting, fixing in position, making riveted / bolted / welded connections and one coat of anticorrosive paint and over it two coats of oil painting, etc. complete.(Bd-C-3/275).

The specification of the work as per standard specification Bd.C3 and the item cover fixing MS/RS girders, M.S. angle, channels, flats, base plate gusset plates, cleat, bracket etc. and other accessories as per requirement and as directed and fabricating the assembly by cutting, drilling holes etc. and erecting and fixing item as site with necessary riveted or welded joints fixtures with nuts and bolts etc. wherever necessary together with their proper fixing and embedding in masonry or slabs of concrete as directed. Structural steel works materials shall be procured by the Contractor from open market at his cost. The item includes 3 coats of oil paint of shade as directed to all structural work. All above operations including cost of materials and labor thereof are included in the tender item. The measurement and payment shall be on the weigh basis in the unit as mentioned in Schedule-B actually erected at site as directed shall be admissible for payment. RSJ channels, angles, flats, gusset plates, brackets base plate, cleats, packing pieces actual used as directed shall be admissible for payment but not the rivets, nuts and bolts etc. the riveted or welded joints or fixing with nuts are included in the tendered rates. The specifications for this item given in Standard Specification (Red Book) published by B&C Department will be followed.

Item No.17: -Providing and fixing in position copper lightening conductor including copper rod of 20 mm dia. as per upper terminal 1.5 M long with a knob at end and with conical spike at top, copper tape conductor 20 x 3 mm size, copper earth plate of 3 mm thick and 0.81 sqm. in area, clamps at 1 M centre to centre including, necessary excavation, laying and fixing the conductor, providing and fixing 40 mm G.I. pipe up to 3 M height from ground and 0.5 M below ground including making all connections, filling earthing pit with charcoal, salt, etc. & refilling & watering, etc. complete as per specifications laid down in relevant I.S. codes.

The contractor shall ensure that any structure. Must or other installation provided by him is adequately designed to minimize damage to the works from lighting strike. Any lighting conductors shall be design in accordance with the edition of the appropriate Indian Standard Code of Practice IS: 2903:1969.

Mode of measurement: -Per No.

SUB WORK NO. 7 & 8: - Sewage Pumping Main 600 mm dia., L – 3470 M & 700 mm dia., L- 2185 M

Item No.1 : - Excavation for Foundation/ pipe trenches for works of Transmission mains, for all types of pipe materials in all types of Soil , earthy or sandy materials, soil of all type of sand, clay mud, Soft Murum ,soft average or hard murum, Boulders, all type of disintegrated rock ,shingles, brick bats ,isolated boulders of any size, all type of rock including soft ,hard and manjara rock by permissible and suitable methods such as Controlled blasting, chiseling, wedging,line drilling and or by use of mechanical means including excavation in all type of road surfaces such as WBM, Asphalt, concrete road, including trimming the surface by chiseling whenever required including removing the roots of trees met with during excavation levelling the bed and keeping it clean and dry by dewatering and making ready for lowering, laying of pipe, manual dewatering, excluding backfilling including removing the excavated stuff upto a distance of 50 m beyond the work site and stacking the same as directed by Engineer in charge etc. complete for lift as mentioned below.

Item No.2: - Excavation for foundation / pipe trenches in hard rock and concrete road by chiseling, wedging, line drilling, by mechanical means or by all means other than blasting including trimming and levelling the bed, removing the excavated material up to a distance of 50 metres beyond the area and lifts as below, stacking as directed by Engineer-in-charge, normal dewatering, excluding backfilling, etc. complete by all means.

Specification as per Sub Work No- 2 Item No. 1 & 2

Item No.3: - Providing D.I. pipes push on joints pressure pipes of D. I. of following class and diameters confirming to the I. S. specification inclusive cost of jointing materials (Rubber gasket of EPDM Quality) excluding GST levied by GOI & GOM in all respect including Third party inspection charges of TPI Agency approved by MJP including Transit insurance, Railway Freight, Unloading from railway wagon, Loading into Truck, Transportation to departmental store, unloading, stacking etc. completed as directed by Engineer in charges (IS 1536/2001 for pipes and IS 158/1969 and IS 12820/1989 or latest edition/ revision with amendments for Rubber Gaskets. **(IS:8329-2000 Latest Version)**)

D.I. K-9 - 600 mm.

1. Scope

This specification covers the requirements for manufacturing, supplying, laying, jointing, testing and commissioning of Ductile iron pipeline and fittings including associated civil works required for the same. Reference should also made to the requirements of Part 6 where appropriate.

1.1 Standards

The following standards, specifications and codes are part of this specification. In all cases, the latest revision of the codes including all applicable official amendments and revisions shall be referred to. In case discrepancy between this specification and those referred to herein, this specification shall govern.

IS: 8329 Centrifugally Cast (spun) ductile Iron pressure pipes for water, gas and sewage.

IS: 638 Sheet rubber jointing and rubber insertion jointing.

IS: 1387	General requirements for supply of metallurgical materials.
IS: 1500	Methods for Brinell hardness test for metallic materials.
IS: 9523	Ductile Iron fittings for pressure pipes for water, gas and sewage.
IS: 12820	Dimensional requirements of rubber gaskets for mechanical joints and push on joints for use with cast iron pipes and fittings for carrying water, gas and sewage.
ISO: 4179	Ductile iron pipes for pressure and non-pressure – Centrifugal cement mortar lining – General requirements.
ISO: 2531	Ductile iron pipes, fittings and accessories for pressure pipe lines.
IS: 5382	Specification for Rubber Sealing Rings for Gas Mains, Water Mains and Sewers
AWWA C600	Installation of ductile iron water mains and their appurtenances.
IS: 11906	Recommendations for cement-mortar lining for cast iron, mild steel and ductile iron pipes and fittings for transportation of water
IS: 3764	Excavation Work – code of Safety.
IS: 12288	Code of practice for use & laying of Ductile iron pipes.
IS: 460	Test sieves – Part I
IS: 8112	Specification for 43 Grade Ordinary Portland Cement.
BS: 3416	Bitumen based coatings for cold application, suitable for use in contact with potable water.
BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and Test Methods.

Manufacturing

1.2.1 General

DI pipes and fittings (Class K9) shall be in accordance with IS 8329 and IS 9523.

Pipes and fittings shall be procured from reputed manufacturers with Engineer's approval. Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing. All tests specified either in this specification or in the relevant Indian Standards specified above shall be performed by the supplier/contractor at his own cost and in presence of Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Engineer. If the test is found unsatisfactory, Engineer may reject any or all pipes and fittings of that lot. The decision of Engineer in this matter shall be final and binding on the contractor and not subject to any arbitration or appeal. The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects. Any defect in pipes and fittings in the opinion of Engineer shall be

rejected and shall be replaced by new one. In the case of spigot and socket pipes and fittings the socket shall be without the centering ring. In the case of flanged pipes the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt-holes shall be drilled and located symmetrically off the centerline. The bolt hole circle shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

1.2.2 Materials

The materials used in the manufacture of pipes and fittings shall comply with requirements specified in IS 8329 and IS 9523

1.2.3 Dimensions and Tolerances

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per the relevant tables of IS 8329/ IS 9523 for different class of pipes and fittings. Pipe class K9 or as per requirement, pipe nominal diameters of 450, 800 and 1000mm and standard length of 6m is recommended and other properties for pipes and fittings shall be as per IS 8329/IS 9523. Each pipe supplied shall be of uniform thickness throughout its length. The tolerances for pipes and fittings regarding dimensions, mass, ovality and deviations from straight line in case of pipes shall be as per IS 8329/ IS 9523.

1.2.4 Testing

a) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS 8329/IS 9523. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS 8329. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS 8329/ IS 9523.

b) Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500. The test shall comply with the requirements specified in IS 1500/IS 8329.

c) Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

d) Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS 8329/ IS 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with 700g hammer for

conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

1.2.5 Joints

a) General

Jointing of DI pipes and fittings shall be done as per IS 12288 and manufacturer's recommendations. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. Rubber sealing rings/gaskets used for jointing shall be of SBR or EPDM rubber and conform to IS 638, IS 12820 and IS 5382.

b) Spigot and Socket joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS 12820. The gaskets/sealant used for joints shall be suitable for water conveyance. In jointing DI pipes and fitting, the contractor shall take into account the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that the rubber ring as per IS 12820 and IS 5382 is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier or as otherwise directed by the Engineer.

c) Gaskets for Flanges

The gaskets used between flanges of pipes shall be of SBR or EPDM rubber conforming to IS 638 of thickness between 1.5 to 3 mm suitable for conveyance of sewage and waste water and as specified by manufacturer.

d) Flanged joints

These shall be of PN 16 rating and shall comply with dimensions and drilling details as specified in IS 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All material shall be supplied by a reputed manufacturer and shall be approved by the Engineer. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The recommended bolting torque to be followed for assembling flanges shall be as specified in manufacturer's instructions. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified. They shall be coated with coal tar epoxy coating after tightening.

1.2.6 Coatings

a) General

Unless otherwise specified, DI pipes and fittings shall be Zinc coated with Bitumen over coating in accordance with following specifications. At buried DI pipes and fittings shall also have factory or site applied polythene sleeving. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected at site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

b) Zinc coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130g/m³ in accordance with ISO 8179.

c) Bitumen coating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions. Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

d) Polythene Sleeving

Where polythene sleeving is specified to be applied in addition to bitumen coating above it shall comply with ISO 8180. Site applied sleeving shall be stored under cover out of direct sunlight and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions. Joints in the sleeving shall be properly overlapped and taped in accordance with manufacturer's instructions to provide in continuous sleeving.

1.2.7 Cement mortar lining

All pipes and fittings shall be internally lined with cement mortar in accordance with ISO 4179/IS: 11906. Cement mortar lining shall be applied at the factory in conformance with the above-mentioned standards. No admixtures in the mortar shall be used without the approval of the Engineer. Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer. Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be 5 mm for DN 450 mm pipe; and 6 mm for DN 800/1000 mm pipes, respectively.

1.2.8 Marking

Each pipe and fitting shall have cast, stamped or indelibly painted on it the following appropriate marks:

- a) The nominal diameter.
- b) Class reference
- c) Mass of pipe.
- d) Date of manufacture and
- e) Manufacturer's name, initials or identification mark.

Marking shall be done as per IS 8329 and IS 9523.

1.2.9 Third party Inspection of the pipes is mandatory in the manufacturing unit. The test certificate shall be produced in this effect by the contractor at his own cost. The agencies performing the TPI shall be enlisted in the list of Maharashtra Jeevan Pradhikaran.

1.3 TRANSPORTATION, HANDLING AND INSPECTION. Transportation – Pipes should be loaded in such a way that they are secured and that no movement should take place on the vehicle during transit.

The pipes should be loaded on vehicles in pyramid or straight sided information. In case of pyramid loading, the pipes in the bottom layer should be restrained by the use of broad wooden wedges secured to the vehicle being loaded. The pyramid is to be formed by resting pipes between the pairs of pieces in the preceding layer with the sockets in layers reversed. Straight sided loading may be used with supports along the sides of the vehicles. The use of straight sided loading is advantageous for utilizing full capacity of the vehicle.

Off – Loading – Cranes should be preferred for off – loading. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used.

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently with safety. The pipes should be lifted smoothly without any jarking motion and pipe movement should be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.

Where the crane operator does not have a clear view, he should be guided by the personnel supervising the operation. When cranes are used, the whole sequence of operation should be carried out smoothly and without snatch. Properly designed hooks and adequate stead ropes are essential. The hooks should be of suitable shape to ensure positive engagement when entered into the ends of the pipes and then should pass over any protective packing fitted around the pipe ends.

The use of slings passed around bundles of pipes is not recommended because bundles become unstable as the sling is drawn tight or released. However, when it is necessary to use the central slinging method for lifting single pipe, a broad webbing sling is recommended which minimizes the risk of the pipe slipping. Chain slings may slip and are dangerous.

Staking – Pipes being taken to a stock ground for storage and held pending further distribution should be arranged into stacks. The first layer of pipes should be laid on a firms formations consisting of solid timers set level on the ground. Subsequent layers should be placed according to the method of staking adopted. Care should be taken so that the pipes do not rest on their sockets. The height of any stack should not exceed 2 m.

Methods adopted for staking pipes are described in above paragraph.

Square Stacking – In square stacking method, second and subsequent layers are set at right angles to the pervious layer with spigots and sockets alternating in each layer and sockets project beyond spigot end. The pipes rest directly upon those beneath it and care is needed in placing to prevent damage.

Parallel Stacking with Timbers -All the pipes are parallel with the sockets of successive layers reversed end-to-end with sockets projecting beyond spigot end.

Timber battens, placed about 600 mm from each end at right angles to the pipes, are used to separate the successive layers. Wedges at both ends of each batten prevent pipe movement.

Nested Stacking (Pyramid Stacking)–Nested stacking consist of placing each pipe between the two pipes underneath it, with the sockets being all at one end of each layer and layer should be firmly anchored to prevent the stack collapse.

Stringing – Stringing consist of placing pipes on the ground in line ready for laying. Care should be taken to prevent damage during this operation.

Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by Engineer and as specified by manufacturer. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fitting/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes and/or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only.

The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for replacement. Any pipe which shows damage in the opinion of Engineer shall be discarded and replaced by new one. Dragging of pipes and fitting/specials along concrete and similar pavement with hard surfaces shall be prohibited.

1.4 INSPECTION OF PIPES: -

The pipes shall be got inspected through EIL/SGS/RITES. All charges of EIL/SGS/RITES inspection shall be borne by the contractor. The testing shall be done as per relevant IS.

Mode of Payment: -

On receipt of the pipe on site 85% payment shall be released and remaining 15% percent payment will be released after Laying & satisfactory hydraulic testing.

1.5 Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at bottom layer to keep the stack shall be in pyramid shape or the pipes laid length wise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5m Fittings/specials shall be stacked under cover and separated from pipes. Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. In the field the rubber rings shall be handled such that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

1.6 Laying

1.6.1 Trenching

Trenching includes all excavation, which is carried out either by hand or by machine and shall be carried out in accordance with all general requirements of civil works specifications mentioned for sub work. In addition to those general requirements, the following requirements shall apply to pipelines:

The excavation shall be done such that it does not get far ahead of laying operations. Before excavating trench, the alignment of pipeline shall be approved by Engineer. Cuttings length and other appurtenances shall be provided to suit detailed pipe configurations required. To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian standards and the rules and regulations of local authorities in regards to safety provisions shall be observed. The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by Contractor and approved by Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organizations or otherwise as Engineer may direct.

Contractor shall take into account additional excavation if any as Engineer may require in order to locate the position of water pipes, drains, sewers etc., or any other works which may be met with, in or about the excavation of trenches while quoting the rates for excavation of trenches while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work. Any damage to the service lines shall be borne by Contractor. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure pipe line of water, gas, sewage etc.

1.6.2 Bedding

The depth and type of bedding shall be as shown on the Drawings and the requirements specified in sub work.

1.6.3 Laying of Pipes and Fittings

Pipes and fittings shall be laid in accordance with IS12288 and manufacturer's instructions. In addition, the requirements specified in Part-6 Clause 6.9.5 shall also be followed.

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipeline of water, gas, sewage etc. After excavation of trenches pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Engineer. Pipes and fittings/specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings shall be made by Contractor. In no case pipes and fittings shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to

fit the ends of pipe and fittings/specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings/specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings damaged during lowering aligning shall be rejected by Engineer and shall be replaced by new one.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer. During the period that the plug's on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2o for 800 and 1000mm; and 3o for 350 mm diameter pipes. The cutting of pipe for inserting valves, fittings or specials shall be done in a neat and workman like manner by using tools and taking precautions as per manufacturer's recommendations without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

1.6.4 Thrust Blocks and Anchor Blocks

Thrust blocks and anchor blocks shall be provided as per the design and drawing provided by the Engineer-in-charge.

1.6.5 Back filling

Trenches shall be back filled with approved selected excavated material only after the successful testing of the pipeline as directed by Engineer. Back filling shall be in accordance with requirements and as directed by the Engineer in Charge.

1.6.6 Pipelines Under Existing Roads

Pipelines laid along a road shall be laid in trench. The sewage rising mains shall be continuously ascending and shall not form many vertical kinks.

1.6.7 Reinstatement of Roads

Reinstatement of roads/footpath shall be done as per the requirements of local authorities and requirements specified in sub work

1.7 Cleaning of Pipes and Fittings

Pipelines shall be cleaned of all dirt, debris, dust or other deposits before hydraulic test to the satisfaction of engineer. The requirements specified in sub work shall be followed.

1.8 Hydraulic Testing

Pipelines and fittings shall be subjected to hydraulic pressure tests in the presence of the Engineer which shall comply with IS 12288 unless otherwise specified.

Testing shall be carried out in two stages:

- a. Test of sections as construction proceeds.
- b. A test of the whole of the pipeline on completion.

The Contractor shall equip himself with all plant, equipment, fittings and water necessary for the hydraulic tests. The Contractor shall submit to the Engineer, well in advance of the time of tests, details of his proposals, including the supply of water either by tankers or bore holes. No connections from the existing pipelines will be allowed, nor will any connections to the pipeline and pipe work which would involve cutting, tapping or altering the Permanent Works be allowed. Test gauges shall be of approved manufacture having dials at least 200 mm diameter, graduated such that the test pressure is at least 75% of the full-scale reading shall be used. If necessary different gauges shall be supplied for different pipeline sections. Two gauges shall be provided for the sole use of the Engineer and shall remain in Engineer's possession for the duration of the Contract. All gauges shall be dead weight tested and calibrated at the commencement of work and at regular intervals as required by the Engineer.

The contractor's arrangements for testing shall include a suitable means of quick installation and removal of the Engineer's gauges during testing.

1.8.1 Testing procedure

The Sectional Hydraulic Test shall be carried out after the pipeline section to be tested has been laid, jointed and back filled to a depth sufficient to prevent floatation, but leaving the joints exposed which have not been tested. The sections to be tested shall be to the approval of the Engineer and shall not be longer than 2000m or 500m when either the pipeline is laid adjacent to or underneath the carriage way or when section includes an air valve chamber. The joints between each tested section shall be left exposed until the pipeline has passed the Test on completion.

In addition to the above requirements the Contractor shall perform a hydraulic test on the first 200 m length of pipeline to be laid under the contract. This test shall be undertaken within one month of the Contractor commencing the laying of pipes. Should the pipeline fail the test or the Contractor fails to undertake the test, all laying and welding work shall come to a halt until that section of pipeline passes a hydraulic test.

Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the forces which will be exerted when the test pressure is applied. Testing against closed valves will not be permitted. Washout valves shall be fitted with blank flanges and these together with in-line valves shall be left open. Air valves already fitted shall be permitted to function during the test.

Proposals for testing where thrusts on structures are involved, even where thrust flanges on the piping are installed, shall be submitted, with the calculations of the forces to be carried, to the Engineer for approval.

The method of filling the pipeline with water shall be approved by the Engineer. The length under test shall be filled making certain that all air is displaced through an air valve installed at the top of the blank flange situated at the high end of the line. The length shall then remain under constant moderate pressure, 10 to 20m head of water, for a period of several hours until the pressure can be maintained without additional pumping.

The pressure shall then be slowly increased at a maximum rate of 1 bar per minute to the full test pressure and pumping discontinued for 3 hours or until the pressure has dropped by 10m, whichever occurs earlier. Thereafter pumping shall be resumed and continued until the test pressure has been restored. The quantity of water pumped restore the pressure shall be the measure of leakage from discontinuation of pumping until its resumption.

The pipe length shall pass the test if the leakage is not more than 1.079 litres per mm diameter per kilometer per 24 hours for each 100m head of pressure applied and the full test pressure has been sustained for at least eight hours.

Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint the Contractor shall, at his own cost, replace the pipe, repair the pipe or re-make the joint and repeat the hydraulic test.

No pipeline shall be accepted until the leakage on any length is not more than the rate of leakage specified above and all sources of leakage have been rectified.

The Test on Completion shall be carried out after all the pipeline sections have been satisfactorily tested and the joints between each section completed to provide a continuous test length between contract interfaces. Pipelines shall be tested as above except where the Engineer issues such instructions as are necessary for testing parts of the Works that have been designed for stresses limited by considerations other than those applying to the pipeline systems.

1.8.2 Test Pressures

Test pressures are to be measured in bars at the center of the blank flange situated at the lowest end of the pipeline under test. Unless otherwise specified or shown on the drawings pipeline test pressure shall be in accordance with the following:

DI pipe and fittings 16 bar

For testing of sections of pipeline containing air valve chambers the Contractor should verify from manufacturer that the air valves are capable of operating under and sustaining the test pressure.

1.9 Pipeline Disinfection

Upon completion of a newly laid main shall be cleaned, disinfected using chlorine solution in accordance with procedure specified in IS 12288. Alternative methods may be adopted with the approval of the Engineer. The chlorinated water shall stand in pipeline for a minimum period of 24 hours and all valves in the system shall be operated twice during this period. The chlorinated water shall be neutralized and disposed off as directed by Engineer.

After final flushing and before the pipeline is placed into service, water samples shall be collected and tested for bacteriological quality and shall not indicate the presence of coliforms. If the initial disinfection fails to produce satisfactory results, disinfection shall be repeated and satisfactory samples are obtained.

The Contractor is expected to carry out the cleaning, disinfecting and dewatering work as a part of laying the pipes and his rates for laying the pipes should include the cost of cleaning and other related works.

1.10 Chamber Markings

Details like valve type, size, cistern number shall be painted on all valve chambers as directed by Engineer. Where valve chambers are flush with the ground, suitable marker posts shall be provided adjacent to the chambers at a suitable location with all details approved by Engineer.

In case of the pipeline laid above ground details such as chainage, invert levels of pipe saddle number culvert number, anchor/thrust block number etc., shall be suitably painted either on the pipeline or the supporting structure in distinct color.

1.11 Measurement and Payment

The measurement for pipes for items specified in Bill of Quantities shall be on running of the net length along the center line of the pipe excluding the length of specials and appurtenances. Payment for pipes shall be made in running meters after production of test certificates specified and directed by Engineer.

Specials shall be paid separately on the basis of each piece used. For the payment purpose, flanges shall be either included in or excluded as described in the Bill of Quantities. However, material such as nuts, bolts and washers, etc., shall be included in the respective items.

Valves and Expansion joints shall be paid on number basis after erection and successful testing.

Mode of Payment: -

Payment shall be done on Rmt basis 50 % of accepted tender rate shall be released only after receipt of DI pipes with third party inspection certificate.

35% of accepted tender rate shall be released only after Lowering Laying Jointing of DI pipes

15 % of accepted tender rate shall be released only after satisfactory Hydraulic testing of laid DI pipes

Item No.4: - Lowering laying and jointing with SBR rubber gaskets C.I. S/S pipes of various classes with CI / MS specials of following diameter in proper position, grade and alignment as directed by Engineer-in-charge including conveyance of material from stores to site of work, including cost of jointing materials and rubber rings labour etc. complete.

Note: Only SBR Rubber gaskets to be used as per IS-5382 and IS-12820.

Mortar inlined D.I.K-9/ K-7 -600 mm without Rubber Rings

Lowering, Laying and Jointing as per Item No. 3, Sub work No.5.

Item No.5: - Hydraulic testing of C.I./D.I. pipe line to specified pressure including cost of all materials and labour and water for testing for specified length including cutting, placing end cap making arrangement for filling safe water using reciprocating type pumps which should be able to provide specified test pressure gauges and other necessary equipments, labour, operation charges, etc. required for testing. The rate under this item shall also include cost of retesting, if necessary and reinstating to original position using water supplied by the contractor.

Hydraulic Testing as per Item No. 3, Sub work No.5.

Item No.6: - Providing and supplying ISI standard D. I. specials & fitting with sealing rubber gasket of S.B. R, complete with cast iron follower gland and M. S. nut bolts coated or otherwise protected from rusting and suitable for D.I. pipes including cost of labour, materials, and transportation to stores, loading and unloading excluding GST levied by GOI & GOM in all respect etc. complete as per IS-9523. For all types of specials, bends tees etc.

350 mm & above dia.

The items include providing, supplying DI specials suitable for diameter as required and of required thickness and including all materials labour charges with epoxy paint from inside and outside including all taxes (Central & local) Octroi if necessary, inspection charges, transportation to stores/ sites & stacking etc. complete. The mode of measurement of payment shall be on weight (Kg) basis

Item No.7 : - Providing and supplying Kinetic Double Orifice type Air Valves confirming to IS 14845 as per MJP's standard specifications combined with screw down isolating valve, small orifice elastic ball resting on a gun metal orifice nipple, large orifice vulcanite ball seating on moulded seat ring, inlet face and drilled, including insurance, third party inspection charges, loading, unloading, transportation up to departmental stores, excluding GST levied by GOI & GOM in all respect etc. complete.

Item No.8: - Lowering, laying and fixing in proper alignment and position all types of C.I. air valves as directed by Engineer-in-charge including cost of conveyance from stores to site of work, cost of all material and giving satisfactory hydraulic testing, etc. complete. (for all class of valves).

Kinetic Air Valve Flanged Type - PN -1- 80 MM

The item includes providing, supplying, laying, jointing with jointing material, commissioning and giving satisfactory test of Kinetic Double Orifice type Air Valve, 80 mm dia, PN 1.0 rating as per MJP's standard specifications having small orifice elastic ball resting on a gun metal orifice nipple, large orifice vulcanite ball seating on moulded seat ring, with built-in kinetic features and isolating sluice valve of same size and rating mounted in horizontal portion, operated by wheel gearing, inlet face and drilled etc. complete.

Approved makes: Kirloskar/ IVI/ IVC/ GavanePatil/ Mayur/ Durga.

Item No.9: - Providing and fixing in position air valve shaft including providing and fixing GI Medium Class or 6 mm thick M.S. pipe shaft 2.70 M long over branch flange of air valve tee, providing PCC block of M-150 concrete, 150 mm thick around the air valve tee including encasing of vertical shaft in PCC M-150 as shown in type design together with providing and making flanged joints wherever required and fixing of air valve tee, etc. complete as per type design and as directed by Engineer -in- charge for following diameters of pipe lines (type design attached.)

Foundation on Murum and Harder Strata-up to 150 MM

Item includes providing 6 mm thick M.S. pipe shaft or G.I. pipe of medium class of 2.7 m Long branch flange tee of Air valve, P.C.C. M150 bed concrete of 150 mm thick and PCC M 150 concrete encasing around the vertical shaft as shown in the drawing as per departmental design & drawing, items include labor charges for fixing the Air Valve over the shaft & laying jointing of flanges etc. ,Item does not include the cost of valves as well as cost of branch flange tee & as directed by the Engineer In Charge. The mode of measurement of payment shall be on Number basis.

Item No.10: - Providing double flange sluice valve conforming for IS- 14846 including orn gear arrangements as per test pressure, stainless steel spindle, caps, including inspection charges, transportation up to departmental store, unloading, stacking excluding GST levied by GOI & GOM in all respect etc. complete.

Item No.11: - Lowering, laying and jointing in position following C.I.D/F Reflex valves, Butterfly valves and Sluice valves including cost of all labour jointing material, including nut bolts and giving satisfactory hydraulic testing etc.

complete. (Rate for all class of valves.)

Sluice valves - PN -1 (Without bypass)-300 MM for Scour Valve

SLUICE VALVES

These specifications cover general provisions and requirements and are supplementary to the General conditions of contract.

GENERAL

The Sluice Valves proposed to be procured through this tender are to be used for drinking water supply schemes under execution.

WORK UNDER THIS CONTRACT

The work entitled manufacture, supply and delivery of Sluice valves for transmission mains shall comprise the manufacture, supply and delivery of the goods as mentioned in the Bill of Quantities.

a) Sluice Valves PN 1.0 of IS: 2906:1984. of various sizes, ranging from 350 mm to 1200 mm.

b) Sluice Valves PN 1.0 of IS:780:1980, of various sizes, ranging from 200 mm to 300 mm.

The manufacturer of sluice valves should be from MJPs approved list

NOTE:

The above goods to be used for conveyance of potable water at temperatures varying from 10 degree centigrade to 40 degree centigrade.

The tender price shall include all labour and machinery and all materials necessary for the proper, manufacture of the goods, for tests at the contractor's works for the insurance and for delivery to works for the proper maintenance and for discharging every obligations and requirement of the contract, in accordance with the intent of the contract documents, as stated in the General Conditions of Contract.

STANDARDS

Where reference is made to a particular standard, it shall be the latest revision of the Indian Standard Institution. Unless otherwise specified, the sluice valves shall be in accordance with the provisions of IS:780:1980 and IS:2906:1984 or sizes of the sluice valves covered under relevant standards.

MARKING OF SLUICE VALVES

Each sluice valve shall be marked as per IS: 780:1980, Para-II for sizes (50 mm to 300 mm) and IS:2906:1984, page: 11.1 (for sizes 350 mm to 1200 mm).

PACKING AND HANDLING

The contractor shall dispatch from the manufacturer's works goods adequately protected to prevent damage and deterioration during transportation and storage, etc. The packing is to be quite robust to withstanding rough handling during the transit by road/ rail/ sea and storage.

Each package / create will contain sluice valve of one size only in relevant class.

The packing procedure followed shall be in accordance with para 12 of IS: 780:1980 and para 12.1 of IS:2906:1984

The contractor shall use proper handling equipment or follow suitable handling method as approved by the Engineer to unload the materials at the delivery site to prevent damage to the goods and equipments.

Third party inspection from agency approved by MJP should be carried out at contractor's cost only.

The contractor should produce manufacturer's test certificate conforming that the valves have been tested in accordance with I.S. specifications, stating the actual pressure and the medium used in the test. The design workmanship, material, strength and dimensions of all parts shall be as per I.S.S. The product shall be of proven quality rendering reliable service during maintenance and requirement.

THIRD PARTY INSPECTION

Third party inspection shall be carried from 1) M/s Central Institute of Plastic Engineering & Technology, Aurangabad. 2) M/s Dr.Amin Controler Pvt.Ltd, Mumbai 3) M/s WAPCOS Ltd., Gandhi Nagar The valve shall be tested in factory by third party in presence of Maharashtra Jeevan Pradhikaran representative at least for

a. Review of martial of construction

b Overall dimension of all component

c. Hydraulic testing.

Mode of Measurement

This item will be measured and paid as per unit basis. and 10 %amount of this item will be withheld for laying and hydraulic testing respectively and will be released after satisfactory laying and hydraulic test.

Item No.12: - Filling in plinth and floors murum bedding in trenches with approved murum from excavated materials from foundation in 15 cm to 20 cm layers including watering and compaction, etc. complete. (Bd-A-10/263)

Specifications same as per Item No. 5, Sub work No.2.

Item No.13: - Providing and laying in situ Cement Concrete M-15 of trap/ granite / quartzite / gneiss metal for foundation and bedding including bailing out water, form work, compaction, curing, etc. complete.

(Cement 5.90 bags / cum)

Specifications same as per Item No. 21, Sub work No.2.

Item No.14: - Providing and laying in situ Cement Concrete of trap/ granite / quartzite / gneiss metal for RCC work in foundation like raft, grillage, strip foundation and footing of RCC columns and steel stanchions including normal dewatering, form work, compaction, finishing and curing, etc. complete. (By weigh batching and mix design for M- 250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement.

Specifications same as per Item No. 1 to 3, Sub work No.4.

Item No.15: - Refilling the trenches with available excavated stuff with soft material first over pipeline and then hard material in 15 cm layers with all leads and lifts including consolidation, surcharging, etc. complete.

Specifications same as per Item No. 18, Sub work No.2.

Item No.16: - Repairing the damaged water supply pipe line of HSC, Electrical/ Telephone/ Other cable including cost of G.I. Pipe and cables with all connection material, labours etc. complete.

Specifications same as per Item No. 36, Sub work No.2.

Item No.17: - Removing and transporting the excavated surplus material of all categories and disposing of the same as directed, including loading, conveying, spreading or stacking beyond the initial lead of 5 Km as directed etc. complete. 5 KM

1) After refilling of trenches, surplus excavated stuff remaining at the site of work have to be disposal off at suitable places within five Km. distance, as directed by Engineer-in-charge.

2) Surplus excavated materials are the property of OMC and therefore contractor is not empowered to sell this excavated material to any other agency.

- 3) This disposal will not be considered for initial 50 M. lead from site of work, so will not be paid for.
- 4) The materials shall be conveyed by means of suitable devices.
- 5) The material conveyed to the place of disposal shall either be stacked or spread as directed by Engineer-in-charge or his representative.
- 6) The route for operation and maintenance, payment of any royalties, compensation to land owners and for damages if any etc. during the process of conveyance etc. shall be the entire responsibility of the contractor.
- 7) This item includes all labours, materials and equipments required for loading, conveyance, unloading, stacking or spreading the material.
- 8) The tender rate shall be for one cubic meter of excavation quantity conveyance to the place of disposal.
- 9) The quantity conveyed and disposed of shall be calculated from the trench excavation after deduction of quantities for bedding, concrete or any other refilled materials and balanced net excavation quantity will be payable under this item.

PROPOSED TREATMENT SCHEME (SBR)

A) RAW SEWAGE PUMPING STATION

1. Receiving of Raw Sewage

The deep gravity outfall sewer shall discharge into receiving chamber of pumping station. From Receiving Chamber it will be taken into downstream screens. The function of the Receiving Chamber is to reduce the incoming velocity. Receiving Chamber shall be of adequate size to meet the requirements of workability inside it. The Receiving Chamber shall be water tight to prevent seepage of the sewage out of the Receiving Chamber.

2. Coarse Screening

Coarse screens are to be provided up stream of Wet well for removal of floating and oversized material coming with the sewage. The coarse screens should be capable to screen out most of the medium & large floating and oversized material such as plastic rags, debris, weeds, paper, cloth, rags etc. which could clog the waste water pump impellers. The coarse screen shall be inclined bar screen (Single or multi rake). It should be of sturdy design to take care of all sorts of materials envisaged in the gravity sewer. The screenings shall be dropped in bin above the top of the screen channel. The screening material as collected will drop into a wheelbarrows for its disposal.

3. Raw Sewage Pumping Station

Screened sewage after coarse screening enters into wet well of the pumping station. The capacity of the wet well should be kept such that adequate detention time is available during average and peak flow conditions. The effective liquid volume shall be provided below the invert level of the incoming sewer after leaving provision for freeboard. The capacity of the sump is to be so kept that with any combination of inflow and pumping the operating cycle for any pump will not be less than 5 minutes. In addition to the above liquid depth, an additional depression shall be provided to ensure adequate submergence of the pump as per the manufacturer's recommendations.

Suitable combination of submersible pumps is to be provided in the sumps to cater the pumping requirements at average and peak flow conditions. Based on incoming

flow conditions, adequate no. of pumps shall operate automatically to cater the pumping requirements.

Suitable arrangement should be provided for lifting of pumps. Electrical panel of the Pump House shall be placed in such a manner to avoid corrosion from gases. Either, it can be clubbed with MCC panel or necessary protection can be given.

The pumped flow from the pumping station shall be taken to the elevated head works Inlet chamber of the STP from where sewage will gravitate to fine screen channels.

B) SEWAGE TREATMENT PLANT

4. Inlet Chamber

Inlet Chamber of STP shall receive the average flow from Raw Sewage Pumping Station through rising main in STP area. From Inlet Chamber it will be taken into downstream Fine Screen Channels. The function of the Inlet Chamber is to reduce the incoming velocity. It shall be of adequate size to meet the requirements of workability inside it. It shall be water tight to prevent seepage of the sewage outside.

2.2.5 Fine Screening

Fine Screens Channels shall be provided upstream of Grit Removal Units. Fine Screens should be capable to screen out most of the small floating materials above 6 mm size. It shall be of Mat type. The screenings shall be dropped in the bin installed at the top of the Fine Screens Channels. The screening material as collected will drop automatically into wheel Barrows for its disposal.

2.2.6 De-gritting

Screened sewage shall gravitate to Grit Separator Tanks for removal of grit and small inorganic particulate matter of specific gravity above 2.65 and particle size above 150 microns. The Grit Separator Tanks shall be of RCC complete with Detritus Mechanism comprising Scraper, Classifier and Organic Return Pumps. The grit separated shall be properly collected and transferred for disposal.

2.2.7 Flow Measurement

Flow measurement shall be done online using an ultrasonic flow meter on the both

rising mains from raw sewage pumping station at STP area.

2.2.8 Sequential Batch Reactor (SBR) Units

Primarily treated sewage shall be fed into the Sequential Batch Reactor (SBR) Process Basins for biological treatment to remove BOD, COD, Suspended Solids, Biological Nitrogen and Phosphorous. Sequential Batch Reactor (SBR) shall work in Cyclic / Batch mode in single step. It shall perform biological Organic Removal, Nitrification, De-nitrification and Biological Phosphorous Removal and shall be capable of simultaneous sludge stabilization. The oxygen required shall be supplied through fixed type Fine Bubble Diffused Aeration System with auto control of oxygen level in the Basins. The system shall have a SVI < 120 for higher settling rates and should be designed in such a way that growth of filamentous bacteria is restricted. The complete operation including Filling of Sewage, Aeration, Sludge Recirculation, Decanting and Wasting of Excess Sludge shall be controlled by PLC. Treated sewage from Sequential Batch Reactor (SBR) Units shall be collected in Chlorine Contact Tank for its further treatment.

2.2.9 Chlorination Tank

Treated sewage from SBR basins shall be collected in a Chlorination Tank where disinfectant will be added for disinfection at suitable dosing rate. Baffle walls shall be provided in the Tank to facilitate hydraulic mixing of treated sewage. Adequate reaction time shall be provided to ensure proper disinfection of treated sewage. The capacity of the Chlorination tank should be kept such that adequate detention time is available during peak / decant flow condition. Treated Sewage from Chlorination Tank shall be discharged into the nearby River.

2.2.10 Sludge Dewatering Units

Excess Sludge from SBR Basins shall be withdrawn through Sludge Withdrawal System and collected in the Sludge Sump. Sludge Sump shall be equipped with suitable submersible mixers to ensure homogeneous mixing.

The sludge shall be then pumped to centrifuge for dewatering using positive displacement type Screw Pumps. Dewatering Polyelectrolyte Dosing System comprising one Solution Preparation and One Solution Dosing Tank equipped with slow speed Agitator and mechanically actuated diaphragm type Metering Pumps

shall be provided to dose Dewatering Polyelectrolyte Solution online.

The dewatered sludge in the form of wet cake from Centrifuge shall be collected whereas Centrate shall be transferred back to the Raw Sewage Sump.

Interconnection of various Units shall be made through DI K-9 pipe or RCC Channels. RCC Pipes shall be preferred over RCC Channels wherever possible but the Executive Engineer reserves the right to select any option.

Indicative Hydraulic Flow Diagram, Process & Instrumentation Diagram and Equipment Layout for the proposed STP are attached at the end of Volume - I. These Drawings are indicative and for tendering purpose only. Bidders need to develop their own drawings based on his design and site conditions, conforming to the specifications given in the Tender documents.

The process selected is a well-established process for treatment of sewage. The Bidders are to adopt the same nomenclature used for various Treatment Units in their design documents as used in the Tender documents. Also the Bidders are required to fill up/complete the Technical Schedules presented in Technical Bid as a part of Tender submission. Any Bid without filled in Technical Schedules shall be considered as non responsive and will be summarily rejected. Bidder shall also note that, the Layout & Hydraulic Flow diagram shall be planned in such a way that necessary space provision shall be made after SBR basins so that suitable filtration system can be added in future, if required.

2. DETAILED SCOPE OF WORK

1. Design Basis:

Sr. No.	Design Parameters	Capacity
A	RAW SEWAGE PUMPING STATION	
1	Average Flow	
2	Peak Factor	
3	Peak Flow	
B	SEWAGE TREATMENT PLANT	
1	Average Flow	
2	Peak Factor	
3	Peak Flow	

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Executive Engineer

4	Dia. of Incoming Gravity Sewer Line (RCC Pipe)	
5	Invert Level of Incoming Sewer at pumping station proposed at STP area at Site	
6	Natural Ground Level (NGL) at Site	
7	Finished Ground Level (FGL) at Site	
8	HFL of nearby River	
9	Approximate min. length of Disposal Pipe	
10	Ground Water Table	
11	Net Safe Bearing Capacity (T/m ²)	
Note: The bidder has to make his own assessment of ground water table & safe bearing capacity while quoting their commercial bid.		

Note: Bidder to carry out necessary soil investigation to ascertain the type of foundation. The same shall be approved by Engineer in charge/consultant.

2 Raw Sewage Quality:

An abstract of Raw Sewage Characteristics is indicated in the following Table:

Sr. No.	Parameters	Values	UOM
1	pH		
2	Biochemical Oxygen Demand (BOD ₅)		mg/l
3	Chemical Oxygen Demand (COD)		mg/l
4	Total Suspended Solids (TSS)		mg/l
5	Total Kjeldahl Nitrogen (TKN)		mg/l
6	Total Phosphorous (TP)		mg/l
7	Oil & Grease		mg/l
8	Fecal Coliform		MPN/100 ml
9	Total Coliform		MPN/100 ml

The Bidder shall carry out the sampling tests of raw sewage by themselves to ascertain the raw sewage quality for treatment process. The Employer will not be responsible for the above and no relaxation will be given to the guarantee conditions of desired treated sewage quality. For design purposes the lower parameters than the above mentioned parameter will not be allowed.

3 Treated Sewage Quality:

The Contractor shall design the process in such a way that the treated sewage quality attains the following limits or even better:

Treated Sewage Quality:

Sr. No .	Parameters / Pollutants		Values after treatment
1	pH	:	5.5 to 9.0
2	Biochemical Oxygen Demand (BOD ₅)	:	≤ 10 mg/l
3	Chemical Oxygen Demand (COD)	:	≤ 50 mg/l
4	Total Suspended Solids (TSS)	:	≤ 10 mg/l
5	Total Phosphorous (TP)	:	≤ 2 mg/l
6	Total Nitrogen (TN)	:	≤ 10 mg/l
7	Ammonical Nitrogen (NH ₃ -N)	:	≤ 1 mg/l
8	Fecal Coliform	:	≤ 100 MPN/100 ml

3. Technical Specifications

A. Raw Sewage Pumping Station in STP area

1. Receiving Chamber

The deep gravity outfall sewers will discharge the raw sewage into a Receiving chamber. The function of the Receiving chamber is to distribute the flow for process units. The Receiving Chamber shall be designed for peak flow. The Receiving chamber shall consist of sluice gates on upstream for flow regulation. In the sidewall of the Receiving chamber, sluice gates shall be installed such that it is possible to operate them manually, inspection as well as operation by standing on a platform constructed at a suitable elevation adjoining and circumventing the receiving chamber. The receiving chamber shall be of adequate size to meet the requirements of workability inside it. The receiving chamber shall be open to sky and shall be water tight to prevent seepage of the sewage out of the receiving chamber. The entire construction is in M30 grade concrete and as per IS 3370. RCC access platform minimum 1200 mm wide with SS 304 pipe railing as per specifications shall be provided on one side of the chamber:

Number of Units : 1 (One)

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Executive Engineer

Detention period : 30 Sec at Peak Flow

Min Free board : 0.50 m above FGL

2. Coarse Screen Channels

One mechanical screen working and one manual screen standby of 20 mm clear spacing and each screen shall be provided of 100% peak flow capacity.

The mechanical and manual bar screens shall be made of 10 mm thick Stainless Steel (SS 304) flats respectively. The mechanical coarse screens shall be of Inclined Rake Type of 20 mm opening as per the specifications detailed elsewhere in the tender. Bin and chute arrangement shall be provided to take the screenings to the screenings dropped from chute will be collected in a wheel burrow. Manually operated CI gates are provided at the upstream and downstream ends to regulate the flow.

Adequate RCC Platforms shall be provided at the upper level to enable operation. Railings shall be provided around the entire periphery of the platform. The entire structure is to be M30 concrete and as per IS 3370 including the platform. RCC staircase 1200 mm wide shall be provided for access from the ground level to the top of the unit & to the operating platform.

Number of Units : Min.1 Mechanical (Working) + 1 Manual
(Standby) each of 100% Peak Flow capacity

Approach Velocity at Average Flow (m/sec) : 0.3

Velocity through Screen at Average Flow : 0.6 maximum
(m/sec)

Velocity through Screen at Peak Flow (m/sec) : 1.2 maximum

Min Free board : 0.50 m above FGL

Wheeled Trolley : 1 No.

All other accessories, whether specified or not, but required for completeness of contract shall be in contractor's scope.

3. Raw Sewage Pumping Station

3.1 Sump and Pumps

Sewage enters into wet well of the pumping station after screening. The wet well shall be circular in shape and shall be designed for average flow. The capacity of the wet well should be kept such that the detention time in the wet well shall be minimum 5 minutes of peak flow and the maximum detention time shall not exceed 30 minutes at average flow. The entire structure is to be M30 concrete and as per IS 3370 including the platform. Following criteria shall be considered to size the sump:

1. That the pump of the minimum duty/ capacity would run for at least 5 minutes considering no inflow or
2. The capacity of the sump is to be so kept that with any combination of inflow and pumping the operating cycle for any pump will not be less than 5 minutes and
3. The arrangement of the submersible pumps as per pump manufacturer's data i.e. spacing between pumps, minimum space between pump and wall etc.
4. The side water depth (live liquid depth) shall be minimum 1.5 meter. In addition to the above liquid depth an additional depression shall be provided to ensure adequate submergence of the pump as per the manufactures recommendations Pumping station should have a room adequate for installing electrical panels. Suitable arrangement should be provided for lifting of pumps.
5. The effective liquid volume shall be provided below the invert level of the screen chamber after leaving provision for a minimum of 0.1 m.

Necessary bypass arrangement shall be provided to be used during the shutdown of the plant.

IS: 3370 and IS: 4111 (part 4) shall be followed for the design and construction of wet well.

The pumps shall be Submersible raw sewage pumps with centrifugal, non-clog type design. The speed of pump shall not be more than 1500 rpm. The impeller should be of a non-clog design with smooth passage and solid handling capability of 100 mm size.

The pumps will have automatic coupling arrangement at discharge end for removal and a guide pipe and chain in SS 304 will be provided for removal and lowering of

pumps. Pump shall run smooth without undue noise and vibration. Vibration shall be limited as per BS 4675 Part I.

The motor shall be squirrel cage type, suitable for three phase supply continuous duty with class 'F' insulation. Motor shall have integral cable parts and the cable entries shall be sealed. Complete rotor shall be balanced dynamically.

Minimum Retention Time : 5 minutes minimum at peak flow.

No. of Pumps for present

Flow : Capacity with Suitable Head (2W+1S)

Type of Pumps : Submersible type non-clog design

Solid passage size : 100 mm max.

Through Pumps

Insulation : Class F

Protection : IP-68

Wet well Specific Requirement, Material of Construction and Accessories:

i. Number of Units : (1) One designed for peak flow

ii. Pumping Station Material of Construction : RCC

Wet well / Sump

iii. Raw Sewage Pump House: RCC above the Wet well to house the panel required for pumps. It shall be RCC (M25) Frame and Brick Masonry Structure equipped with Doors, Windows/Ventilators, etc. complete. Also, it shall be provided with Flooring, Internal and External Plaster with Painting.

The size of the sump shall be suitable to accommodate the number of pumps required for operation with easy manoeuvrability.

Raw Sewage Sump shall be provided with following:

i. Electrical Hoist - comprising of I-Girder and a 1½ ton or more chain pulley (the chain pulley block capacity to be 1½ Ton or 1.5 times the maximum single unit/ weight that may be required to be removed for maintenance) with horizontal travel on the I-beam.

Pumps Configuration	:	As mentioned above
Liquid	:	Raw Sewage
Specific gravity	:	1.05
Temperature	:	Min. 20° C
Efficiency	:	more than 70%
Installation	:	Fixed.
Casing	:	Cast Iron IS 210 Gr. FG 260
Impeller	:	Cast Iron IS 210 Gr. FG 260
Shaft	:	AISI 410
Cable gland	:	Cast Iron IS 210 Gr. FG 260
Motor Body	:	Cast Iron IS 210 Gr. FG 260
Seal cover	:	Cast Iron IS 210 Gr. FG 260
Automatic Coupling	:	CI
Duck foot bend	:	CI
Guide Pipe	:	SS 304
Lifting chain	:	SS 304
Fasteners	:	MS with GI coating

Testing of Pumps at Manufacturers Premises:

- a) Hydrostatic Testing: All pressure parts of pumps prior to assembly, shall be subjected to hydrostatic tests to the satisfaction of Executive Engineer at 1.5 times the maximum pressure obtained with the delivery valve closed and suction pressure at maximum, or twice the working pressure whichever is higher for a duration of 10 minutes.
- b) Balancing Test: Impeller and pump rotating assembly shall be dynamically balanced.
- c) Performance Test: Each pump shall be tested for full operating range individually to BS: 5316: Part 2. Test shall be carried out for performance at rated speed with minimum NPSH as available at site.
- d) Pump performance shall be within the tolerance limits specified in BS: 5316: Part 2.

4. Rising Main

The pumped flow from the pumping station to the elevated head works inlet chamber of the plant shall be taken through a DI - K-9 pipeline including all specials, valves, air valves, thrust block of M-20 grade if required etc. The rising main shall be designed for average flow with peak flow.

(a) The pipeline shall be adequately sized to have a minimum velocity of at least 1.2 m/s at minimum flow conditions and not more than 2.5 m/sec at pumped peak flow.

(b) The pump head shall be adequately sized to give a residual discharge head as per CPHEEO manual.

A suitable plant bypass shall be provided from the pumping station to divert sewage in case of emergency.

B. Sewage Treatment Plant

1.0 Primary Treatment Units

Primary Treatment Units comprising Inlet Chamber, Fine Screen Channels and Grit Chambers shall be designed for Peak Flow.

1.1 Inlet Chamber

Inlet Chamber of STP shall receive the flow from raw sewage pumping station located within STP area. Inlet Chamber shall be designed for Peak Flow. The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370. RCC Platform/Walkway, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit & to the Operating Platform/Walkway.

Number of Units : 1 No.

Hydraulic Retention Time : 30 Sec at Peak Flow

Free Board : 0.50 m min.

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

1.2 Mechanical & Manual Fine Screen Channels

Min. 1 Mechanical Fine Screens (Working) and one Manual Fine Screen (Standby) shall be provided in Fine Screen Channels. Each Fine Screen Channel shall be designed for 100% of Peak Flow.

The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370. RCC Platform/Walkway, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit & to the Operating Platform/Walkway.

The clear opening shall be 6 mm for Mechanical Fine Screen and 10 mm for Manual Fine Screen. The Mechanical and Manual Screens shall be made of SS 304 flats (3 mm for Mechanical and 10 mm for Manual Screen). Bin and Chute arrangement shall be provided to take the screenings. Screenings dropped from Chute shall be collected in a wheel Burrow. Manually operated CI Sluice Gates shall be provided at the upstream and downstream ends to regulate the flow.

Number of Units : 1 Mechanical (Working) + 1 Manual
(Stand by) each of 100% of Peak Flow capacity.

Approach Velocity at Average Flow : 0.30 m/s

Velocity through Screen at Average Flow : 0.60 m/s max.

Velocity through Screen at Peak Flow : 1.20 m/s max.

Free Board : 0.30 m min.

Wheel Barrow : 1 No. min.

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

1.3 Grit Chambers

Two Mechanical Grit Chamber (Working) along with one Manual Bypass Channel

(Standby) shall be provided after Fine Screen Channels. The Grit Chamber shall be designed for 50% of Peak Flow and the Bypass Channel shall be designed for 50% of Peak Flow.

The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370. RCC Platform/Walkway, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit & to the Operating Platform/Walkway.

Each Grit Chamber shall have the following features:

- One tapered Inlet Channel running along one side with adjustable Influent Deflectors for entry of sewage into the Grit Chamber.
- One tapered Outlet Channel for collecting the de-gritted sewage, which overflow over a adjustable Weir into the Outlet Channel. It shall be designed in such a way that no settling takes place in it.
- One sloping Grit Classifying Channel in to which the collected grit shall be classified.
- The grit from Classifier shall be collected in a Wheeled Trolley.
- A Grit Scraping Mechanism.
- Screw Classifier or Reciprocating Rake Mechanism to remove the grit.
- One Organic Matter Return Pump

Manually operated CI Sluice Gates shall be provided at entrance of the Inlet Channel of the Grit Chambers as well as Bypass Channel to regulate the flow.

No. of Units : 2 Mechanical (Working) of 50% of Peak Flow capacity

Type : Mechanical

Size of grit particle : 0.15 mm

Specific gravity of grit : 2.65

Maximum Surface Overflow Rate : 960 m³/m²/day

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Free Board : 0.30 m min.
Side Water Depth : 0.90 m min.
Wheel Barrow : 1 No. minimum

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

Flow Measurement

Flow measurement shall be done online using an ultrasonic flow meter on the rising mains from raw sewage pumping stations located at STP area.

2.0 Sequential Batch Reactor (SBR) Units

2.1 General

The Sequential Batch Reactor (SBR) Process shall be an advanced activated sludge process with in-built nitrification, de-nitrification and biological phosphorous removal. The process shall utilize a Fill-and-Draw Reactor with complete-mix regime and operating in true-batch mode. The complete process shall be divided into Cycles with each Cycle is of duration of 2 - 4 hours. All the subsequent treatment Steps - Fill/Aeration, Settling and Decanting must take place sequentially and independently without overlapping. During Fill/Aeration phase, the sewage shall be filled into SBR Basins and part of the treated sewage along with activated sludge shall be recycled with the help of Recycle Pumps. Air shall be supplied for aeration with the help of Air Blowers. During settling phase, the Filling/Aeration shall be stopped and the mixed content shall be allowed to settle under perfect settling conditions. During Decanting phase, the supernatant shall be removed from top with the help of Decanters and excess sludge shall be wasted with the help of Waste Pumps.

The Bidder shall provide the most advanced and proven SBR technology being in successful operation for at least 5 years as on date and meeting Standards of the Treated Sewage / Sewage Quality as mentioned vide Clause 2.3.3 above in Indian conditions. The performance of the same shall be demonstrated by providing necessary Authenticated Certificates issued by the competent authority.

2.2 Process Design

- Sequential Batch Reactor (SBR) Units shall be installed and equipped for average flow.
- The SBR Process shall have following independent steps without overlapping each other:
 - Fill & Aeration
 - Settling (Sedimentation/Clarification)
 - Decanting (Draw)
- Filling, during Settling or Decanting will not be acceptable.
- The complete biological system shall be designed for handling peak flow.
- Suitable Nos. of SBR Basins with adequate volume shall be provided. In addition, 0.50 m Free Board shall be provided to each Basin.
- The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370. RCC Platform/Walkway, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit & to the Operating Platform/Walkway. Plinth protection along periphery shall be provided as per technical specifications.
- The system should work on a gravity influent condition. No influent / sewage Equalization Tanks or flash filling is accepted.
- The system should be designed for maximum F/M ratio of 0.18 Kg BOD/Kg MLSS day.
- MLSS maintained in the Basin should range from 3500 to 5000 mg/l.
- Cycle times shall be selected adequately by the Bidder considering min. 12 hrs/day Basin of aeration and not exceeding decanting of 2.40 m liquid depth at any time with preferred cycle times containing max. 50% not aerated portion.
- The excess sludge produced shall be fully digested. Sludge production

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(including percipients) rate shall be about 0.60 - 1.20 Kg / Kg of BOD removed.

- A minimum total SRT of 10 days shall be maintained to ensure digested sludge.

2.3 Decanting Device

- The Decanting Device shall be Moving Weir Arm Device of SS 304 with top mounted Gear Box, Electric Drive, Scum Guard, Down comers, Collection Pipe, Bearings. The maximum design travel rate shall be 60 mm/min with proven hydraulic discharge capacity of the decanter proportional to the selected Basin area.
- There should be maximum one (1) Decanter per Basin.
- The hydraulic design based on design flow rate as given above shall not exceed flow speed of 1.30 m/s.
- Flexible rubber hose kind of decanter Sealing is not acceptable.
- One or more decanters shall be provided in each basin which functions under a controlled lowering rate to withdraw treated water out of SBR / Cyclic Activated Sludge Process Basins.
- The decanting mechanism shall be designed for a variable speed mode of operation. Decanter shall be capable to travel at varying speeds. The rate of travel of the decanter shall be adjustable during its travel in air and into the liquid surface, at which point the rate of travel of the decanter shall be automatically adjusted to a calculated rate of operation. The maximum design travel rate shall be restricted to 60 mm/min. Rope driven or Fixed subsurface arrangements will not be acceptable.
- The rate of operation shall be calculated for each cycle and shall be determined by the volume of treated effluent to be discharged per cycle. The calculation of decanter travel shall ensure that the volume of treated effluent shall be discharged throughout the designated decant phase of the process cycle. The travel of the decanter shall be limited and controlled by limit switches which shall communicate with the PLC. Upon reaching the designated BWL, the decanter shall return to its parked position.
- During non-decanting cycles, the decanter collection weir shall be parked

above the top water level of the basin during aeration and settling phases, thereby eliminating any possibility of solids carryover during these phases. Therefore weirs or entry ports of the Decaners shall not be submerged below the top water level of the basin during non-decant phase. Each decanter shall be fitted with a scum retention mechanism to prevent surface scums and floatables from exiting with the treated effluent.

- In addition, at park position, the decanter shall also provide fail safe overflow protection in the event of a power failure by allowing clear supernatant to flow via gravity, under the scum guard, over the weir, and into the decaners and out of the basins.
- If more than one decanter is provided per basin, operation of all decaners shall be synchronized precisely using synchronization panel to achieve even distribution of flow through each decanter.
- Weir loading for each decanter shall not exceed 140 m³/hr/m of the inlet weir. During Decanting Phase, decanter weir shall always be visible from the basin walkway to provide the operator with a visual check of the effluent quality. Maximum velocity down comer shall not exceed 1.0m/sec. at the designed decant flow.
- All components of the decanter except seals and bearings shall be constructed of stainless steel 304. The decanter seals and bearings shall be constructed of maintenance free, synthetic materials for longest possible service life. All seals and bearings shall be shipped factory assembled, simplifying installation. All fasteners shall be constructed of 304 stainless. Site fabrication of decaners shall not be allowed.
- Drive mechanism or actuator shall be equipped with variable frequency drive connected to PLC to facilitate its operation at varying flow rates to ensure controlled and seamless operation at varying flow rates. Complete Drive Mechanism shall be mounted on the walkway to provide easy access for maintenance and service purposes.
- All critical decanter components that may require routine inspection or

maintenance shall be easily accessible from an access platform at basin coping level without taking a basin out of service or draining or partially draining the basin. It shall be possible to carry out decanter maintenance activities without interrupting normal operation of the basin while the decanter is at its parked position during non-decant phases of the process cycle.

- The SBR blowers, Automatic Air supply Valves, RAS Pumps/Mixers, switching mechanism shall be interlocked with the decanter controls so that aeration/mixing is prevented in a basin which is settling or decanting.

2.4 Aeration System

- The aeration facility shall be installed for average flow.
- Only Fine Bubble Type, PU Membrane Diffusers shall be acceptable with minimum Membrane Diffusers to Floor Coverage Area of 5%. Combination of aeration techniques using Aerators/Submersible Mixers etc. is not acceptable. Diffusers shall be submerged, fine bubble / fine pore, high transfer efficiency, low maintenance and non-buoyant type. Diffusers shall be panel / tubular type. In case tubular type Diffusers are used, only top half surface area of the Diffuser shall be considered for supply of air. Material of construction for entire under water system including accessories shall be of non-corrosive. Complete Diffuser as a unit shall be assembled at the manufacturing factory level. The grid supports shall be of adjustable type made of SS 304.
- The Air Blower Arrangement shall be capable of handling Total Water Level and Bottom Water Level operation conditions controlled by process sensors such as DO, Temperature and Level.
- Each set of Air Blowers shall have dedicated standby. Minimum one working Air Blower in each set shall operate via VFD while others may be operating at a fixed constant speed on soft starter configuration.
- The Air Blowers shall be positive displacement (Roots) type and head for Air Blowers shall be decided on the basis of S.O.R. of Diffusers and maximum Liquid Depth in Basin duly considering the losses governing point of delivery (Diffusers)

and the Air Blowers. Air Blowers shall be complete with Motor and accessories like Base Frame, Anti Vibratory Pad, Reactive Silencer, Non Return Valve, Air Filter etc. as per requirements. Further, Air Blowers shall have acoustic enclosure to ensure that the noise level at 2.00 m from Air Blowers is below 85 db. The Air Blower House shall have Rolling Shutter, Windows, Exhaust Fans, Safety Equipments with sufficient Ventilation, Lighting and Working Space. It shall be equipped with sufficient capacity Electrical Hoist with Travelling Trolley (Min. 3 Ton or 1.5 times the weight of Air Blower whichever is more) to facilitate removal of Air Blower / other Accessory for repairs.

- The operation of Aeration System shall include PLC based control. The operation and speed of Air Blowers shall be automatically adjusted using parameters like Oxygen Uptake Rate, Dissolved Oxygen and Temperature and Liquid Level in the Basin such that the DO is supplied as per demand and power utilisation for operation of Air Blowers is optimised.
- The main Air Header/Ring Main shall be in MS as per relevant IS Code, painted with corrosion resistant paint as per Manufacture's recommendations. The Air Header/Ring Main shall be supported on saddles at suitable intervals or shall be protected against external corrosion in case laid below ground. The Sub-header shall have Auto Valves to facilitate switch over of Aeration Cycle from one Basin to other by PLC. The Sub-header shall supply air to Fixed Type Diffuser Grids at various locations through vertical Air Supply Pipes. These Air Supply Pipes above water level shall be in MS, painted with corrosion resistant paint and below water level shall be in SS 304. All under water Lateral Pipes shall be of UPVC. Junctions between horizontal Sub-header and vertical Air Supply Pipes shall be suitably protected against corrosion due to dissimilar materials.
- All other accessories, whether specified or not, but required for completeness shall form part of Contractors scope.

2.5 Return Sludge and Excess Sludge Pumps

Dedicated Return Sludge and Excess Sludge Pumps shall be provided in each SBR Basin. The Pumps shall be of submersible / horizontal centrifugal type suitable for handling biological sludge of 0.8 - 1% solids consistency. Capacity and Heads shall

be decided based on process requirements. Each Basin shall be provided with suitable lifting arrangements to facilitate lifting of these Pumps if required for maintenance.

Return Sludge Pumps

Capacity and Head	: As per requirements
Type	: Submersible / Horizontal Centrifugal
Liquid	: Biological Sludge of 0.8 - 1% solids consistency
Specific gravity	: : 1.05
Solid size	: 40 mm (Maximum)
Temperature	: Min. 25° C
Efficiency	: more than 50%
Quantity	: 1 No. per Basin + 1 No. Store Standby

b. Excess Sludge Pumps

Capacity and Head	: As per requirements
Type	: Submersible / Horizontal Centrifugal
Liquid	: Biological Sludge of 0.8 - 1% solids consistency
Specific gravity	: : 1.05
Solid size	: 40 mm (Maximum)
Temperature	: Min. 25° C
Efficiency	: more than 50%
Quantity	: 1 No. per Basin + 1 No. Store Standby

2.6 Automation and Control

- PLC based Automation System with application software based on Rockwell or equivalent to control SBR System including all Gates, Air Blowers, Pumps, Valves and Decanters as per Bidder's/Technology Provider's own design including I/Os with 20 % Spares and UPS.
- HMI Panel shall comprise latest Personal Computer with 22" LCD Monitor, Multi Media Kit, Printer, Internet Connection, RS-View, RS-Links (Gateway Version), Process and Operator Software with dynamic Flow Charts, Pictures, Screens, Alarms, Historical Trends, Reports etc.

• SCADA based Automation System to monitor the following parameters continuously in each SBR Basins:

- Fill Volume
- Discharge Volume
- Temperature
- DO Level
- Oxygen Uptake Rate
- Air Blower Speed
- Decanter Speed

3.0 Disinfection (Chlorination) Units

Disinfection (Chlorination) Units including Chlorination Tank and Chlorinator cum Chlorine Tonner House shall be designed for Average Flow or Decant Flow whichever is higher.

3.1 Chlorination Tank and Chlorinator cum Chlorine Tonner House

Treated sewage from SBR basins unit shall be taken to Chlorination Tank by RCC Channel/RCC NP-III pipe. Gas Chlorine shall be added for disinfection at suitable dosing rate. Baffle walls shall be provided in the Tank to facilitate hydraulic mixing of treated sewage. The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370.

Design Flow : Average Flow or Decant Flow whichever is more

Number of Units : 1 No.

Hydraulic Retention Time : 30 Minutes (excluding Outlet Channel after Weir)

Free Board : 0.50 m min.

A Chlorinator cum Chlorine Tonner House shall be provided above/near Chlorination Tank to house Chlorination Systems. It shall be RCC (M25) Frame cum Brick Masonry Structure with Rolling Shutter, Windows & Ventilators, Electrical Hoist with Electrical Travelling Trolley of minimum 3 Ton capacity or 1.5 times the weight of the single Unit whichever is more to lift the Pumps/Chlorine Tonners and Safety Equipments including Sand Buckets, Fire Extinguishers and Fire Alarms etc. Also it shall be provided with IPS Flooring, Internal & External Plaster and Internal & External Painting. Plinth Protection shall be provided along the periphery as per

specifications.

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

3.2 Chlorination System

Gas Chlorination System comprising Vacuum Chlorinators (2 Nos.), Water Feed Pumps (2 Nos.), Interconnecting Piping and Appurtenances, Chlorine Gas Detector, Empty Chlorine Tonners (Suitable for 30 days' Storage) with Trunions, Lifting Device and Suspended Weighing Scale, Residual Chlorine Test Kit, Safety Equipment (e.g. Exhaust Fan, Canisters, Gasmasks etc.), Mandatory Spares, Chlorine Leak Detection and Chlorine Leak Absorption System including FRP Half Hoods, Caustic Solution Tank, Caustic Recirculation Pump, Centrifugal Fan, Interconnecting Piping and Ducts complete and other required ancillary shall be provided.

Design Flow : Average Flow or Decant Flow whichever is more

Type : Vacuum Type

Chlorine Dosing : 5 ppm min.

Quantity of Chlorinator : 2 Nos. (1Working + 1Standby)

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

4.0 Sludge Dewatering Units

Sludge Dewatering Units comprising Sludge Sump and Pump House, Centrifuge House and Dewatering Polymer Dosing System shall be designed for Average Flow.

4.1 Sludge Sump & Pump House

A Sludge Sump shall be provided to hold excess sludge from SBR Basins. It shall be equipped with a submersible mixer to facilitate mixing of its contents on continuous basis. It shall be constructed in M30 grade reinforced cement concrete and as per IS 3370.

Number of Units : 1 No.

Hydraulic Retention Time : 6 hrs. min. of Average Daily Sludge Production

Free Board : 0.50 m min.

A Pump House shall be provided near Sludge Sump to house Sludge Transfer Pumps

(Centrifuge Feed Pumps). It shall be RCC (M25) Frame cum Brick Masonry Structure with Rolling Shutter, Windows & Ventilators and Electrical Hoist with Electrical Travelling Trolley of minimum 1 Ton capacity or 1.5 times the weight of the single Unit whichever is more to lift the Pump and Safety Equipment including Sand Buckets, Fire Extinguishers etc. Also it shall be provided with IPS Flooring, Internal & External Plaster and Internal & External Painting. Plinth Protection shall be provided along the periphery as per specifications.

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

4.2 Sludge Sump Mixers & Sludge Transfer (Centrifuge Feed) Pumps

Submersible mixer (<500 rpm) shall be provided inside the sludge sump to keep the sludge in suspension. The material of construction of the mixer shall be SS304 along with lifting device with SS 304 square tube.

All other accessories, whether specified or not, but required for completion of Contract shall form the part of Bidder's Scope.

Sludge Transfer (Centrifuge Feed) Pumps shall be of positive displacement type Screw Pumps suitable for handling biological sludge of 0.8 - 1% solids consistency.

Type	: Positive Displacement Type Screw Pump
Liquid	: Biological Sludge of 0.8 - 1% Solids Consistency
Specific gravity	: : 1.05
Solid size	: 40 mm (Maximum)
Temperature	: Min. 25° C
Efficiency	: more than 30%
Quantity	: As per requirement + 1 Standby Min.

All other accessories, whether specified or not, but required for complete shall form part of contractors scope.

4.3 Mechanical Sludge Dewatering Device (Centrifuge) and Centrifuge Platform

The Mechanical Sludge Dewatering Device shall be solid bowl type Centrifuges designed for 100% trouble free operation at all times and provided as per the following guidelines.

- The device shall be so located that the dewatered sludge can be loaded into Trucks/ Trolleys / Containers directly. Preferably the device shall be so located that the dewatered sludge falls into the Trucks/ Trolleys / Containers without requirement of another Material Handling Unit.
- The dewatered sludge shall have a minimum solids concentration of 20% or more (measured as dry solids w/w basis) so that it can be disposed by open body Trucks/Trolleys.

The Centrifuge shall be solid bowl type of co-current/counter current design, as decided by the Bidder. It shall have sufficient clarifying length so that separation of solids is effective. The Centrifuge and its accessories shall be mounted on a common Base Frame so that the entire assembly can be installed on an elevated structure. Suitable Drive with V-Belt arrangement and Turbo Coupling shall be provided along with Overload Protection Device.

Differential speed and Bowl speed shall be adjusted by changing the Pulleys. Differential speed may be adjustable by use of epicyclical gears. The Bowl shall be protected with flexible connections so that vibrations are not transmitted to other Equipments. The Base Frame shall be provided with anti-vibration Pads. The Drive Motor shall be of 1,450 RPM. The noise level shall be 85 dB (A) measured at 2.00 m distance under dry run. The vibration level shall be below 50 micron measured at Pillow Blocks under dry run condition.

Operating Hours	: 18 hrs per day maximum
Type	: Solid Bowl Type
Liquid	: Biological Sludge of 0.8 - 1% Solids Consistency
Specific gravity	: : 1.05
Quantity	: As per requirement + 1 Standby Min.

All other accessories, whether specified or not, but required for complete shall form part of contractors scope.

A Centrifuge Platform shall be provided near Centrifuge Feed Pump House to house Centrifuges. It shall be a G(Stilt) + 1 type RCC (M25) Frame Structure. Centrifuges shall be installed at First Floor whereas Trucks/Trolleys/Containers shall be parked at Ground Floor. An Electrical Hoist with Electrical Travelling Trolley of minimum 3 Ton capacity or 1.5 times the weight of the single Unit whichever is more and Safety Equipment including Sand Buckets, Fire Extinguishers etc. shall be provided. Also it shall be provided with Anti-Skid Tile Flooring, Internal & External Plaster and Internal & External Painting. Plinth Protection shall be provided along the periphery as per specifications.

4.4 Polyelectrolyte Dosing System

Polyelectrolyte shall be dosed online at the inlet of Centrifuge. Minimum dosage of polyelectrolyte shall be 1.50 - 2.50 Kg/Ton of dry solids in sludge at 0.1% solution strength. There shall one Solution Preparation Tank and one Solution Dosing Tank, each suitable for minimum 8 hrs. of operation and quipped with slow speed Mixer (100 RPM). The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370. RCC Platform/Walkway, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with SS 304 Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit & to the Operating Platform/Walkway.

Number of Units : 2 Nos.

Hydraulic Retention Time : Suitable for min. 8 hours of Operation

Free Board : 0.50 m min.

The solution will be dosed using mechanically actuated diaphragm type Metering Pumps. Dedicated Dosing Pumps shall be provided and shall be interlocked with Centrifuge in such a way that they Start/Stop along with Centrifuge.

Type : Mechanically Actuated Diaphragm Type Metering Pump

Liquid : Polyelectrolyte Solution of 0.1% Strength

Quantity : As per requirement + 1 Standby Min.

5.0 Plant Utilities

5.1 SBR Air Blower cum Administrative cum MCC & PLC/Control Building

The SBR Air Blower cum Administrative cum PLC/Control Building (min. 120 sqm on each floor) shall be G+1 type RCC (M25) Frame and Brick Masonry Structure. SBR Air Blower House, Workshop & Tool Room shall be constructed at ground floor whereas Administration Block (comprising Office, Conference Hall and Laboratory), PLC/Control Room shall be placed at first floor.

PMCC, HT Substation shall be placed in separate Structure.

SBR Air Blower House shall house Air Blowers for SBR Basins. It shall be equipped with Rolling Shutters, UPVC Windows/Ventilators, Exhaust Fans and Electrical Hoist with Travelling Trolley (Min. 3 Ton or 1.5 times the weight of Air Blower whichever is more) to facilitate removal of Air Blower / other Accessory for repairs. Similarly, PLC/Control Room shall be designed.

Laboratory shall be fully equipped with all necessary Equipments, Instruments, Chemicals, Reagents, Glassware and Furniture.

Adequate number of Toilets and Washbasins shall be provided separately for Men & Women at each floor. A covered Overhead Tank of capacity 5 m³ shall be provided along with an Underground Water Tank of capacity 10 m³ to cater to the water requirements of the Building.

In addition, the Building shall be provided with Porch, Staircase, Passages, Wooden/Aluminium/Glass Doors / Windows / Ventilators and Safety Equipment including Sand Buckets, Fire Extinguishers and Fire Alarms etc. Adequate Flooring shall be provided in various Rooms/Areas as per requirement or as per instructions of the Engineer-in-charge. Internal & External Plaster with Painting shall be done as per instructions of the Engineer-in-charge. Plinth Protection shall be provided along the periphery as per specifications.

The Building shall be provided with the following:

Sr. No.	Item of work	Work
1	Personal Computer in PLC/Control Room	2 Nos. of latest version & configuration complete.

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2	Printer in PLC/Control Room	1 No. of A3 Size Laser Printer of latest version & configuration complete.
3	Telecommunication Facility	Min. 1 No Telephone Line with a Broad Band facility. The chargers will be born by the Contractor up to the O & M Period.
4	Plant Model	• 1 No. Wall Mounted Process Model (Electronic Plant Display Model) with Flow Diagram (Minimum size 3 m x 1.5 m) • 1 No. 3D Model with display of flow direction and lighting.
5	Air Conditioner	Adequate nos. of Air conditioners shall be provided as directed by Executive Engineer.

5.2 Electrical HT Substation

The Electrical HT Substation (min. 150 sqm) shall be provided to house HT Components comprising Metering Kiosk, HT Panel and Power Control Centres. It shall be RCC (M25) Frame and Brick Masonry Structure equipped with Rolling Shutters, Windows/Ventilators, Exhaust Fans and Safety Equipment including Sand Buckets, Fire Extinguishers and Fire Alarms etc. complete.

Also, it shall be provided with IPS Flooring, Internal and External Plaster with Painting and Plinth Protection along the periphery as per specifications.

5.3 DG House

The DG house (min. 50 sqm) shall be provided to house DG Set of adequate rating capable of running the entire STP and pumping station located in STP area at Peak Flow including AMF Panel, Fuel Tank and other Accessories. It shall be RCC (M25) Frame and Brick Masonry Structure equipped with Rolling Shutters, Windows/Ventilators, Exhaust Fans and Safety Equipment including Sand Buckets, Fire Extinguishers and Fire Alarms etc. complete. Also it shall be provided with IPS Flooring, Internal and External Plaster with Painting and Plinth Protection along the periphery as per specifications.

5.4 Security Cabins

Security Cabin of size 3.00 m x 3.00 m shall be provided at entry Gate of the Plant. It shall be RCC (M25) Frame and Brick Masonry Structure equipped with Doors,

Windows/Ventilators, etc. complete. Also, it shall be provided with Flooring, Internal and External Plaster with Painting and Plinth Protection along the periphery as per specifications.

5.5 Schedule of Finishes

Sr. No.	Unit	Flooring	Doors	Windows / Ventilators
1	Administrative Block, Laboratory, MCC Room, PLC & Control Room, Security Cabins	Marbonite flooring of approved make. The size of Marbonite tiles shall be min 600 mm x 600 mm & thickness min 10 - 12 mm	Solid Core Flush Door with heavy duty Brass Fittings of approved make	Aluminium of approved make
2	SBR Air Blower House, Workshop & Tool Room, Chlorinator cum Chlorine Tonner House, Sludge Pump Houses, Electrical HT Substation, DG House	IPS Flooring with Abrasion Resistant Additives of approved make	MS Rolling Shutter (See Through Type) of approved make	Aluminium of approved make
3	Centrifuge Platform	Anti Skid Tile Flooring of approved make	---	---
4	Vehicle Parking Area	Coloured Pre-cast Heavy Duty Paving Blocks with Lacquer Finish	---	---
5	Toilet Blocks	Coloured Glazed Tiles	UPVC of approved make	UPVC of approved make
6	Staircase: Inside Building	Grey Granite Flooring of approved make	---	---

5.6 Roads, Pathways & Vehicular Parking Area

Contractor

No. of correction

Executive Engineer

All internal Roads (min. 400 m long) shall be provided with Drainage and constructed to prevent standing water. All Roads shall be minimum 5.0 m wide WBM road of thickness 0.225 m compacted excluding casing grade-I GSB of 0.15 m thick and grade-II GSB of 0.075 m thick including spreading in uniform thickness, handpacking to proper grade and camber, applying and brooming requisite type screening/binding material to fill up the interstices coarse aggregate, watering and compacting with power roller complete, with hard murum casing of thickness 0.30 m compacted. BM shall be 75 mm thick (4% bitumen content) and AC shall be 40 mm thick with (6.25% bitumen content) as directed by Engineer-In-Charge.

Pathways shall be constructed interconnect the entire Plant with Roads. Minimum width of pathways shall be 2.00 m. Pathways shall be in coloured Pre-cast Heavy Duty Paving Blocks of 60 mm thick of M-20 grade with Lacquer Finish including the sub base of 0.23 m thick soling and as directed by Engineer-In-Charge.

Vehicle Parking Area shall be provided to permit the parking of Vehicles in coloured Pre-cast Heavy Duty Paving Blocks with Lacquer Finish.

The entire system of Roads, Pathways and Vehicle Parking Area shall be designed such that Vehicles involved in the delivery of Materials, Chemicals, Consumables and Residual Disposal can continuous route through the Works and get out again.

5.7 Storm Water Drainage

Adequate Storm Water Drainage shall be provided adjacent to the Internal Roads considering local rainfall intensity with 100% runoff. It shall be in RCC Class NP 3 pipe of min 600 mm dia. with necessary Chambers at appropriate locations. These Chambers shall be covered with RCC chambers. This Storm Water Drainage shall be connected to the nearby Storm Water Drain or Channel of City Network.

5.8 Boundary Wall with Gate

Boundary Wall shall be constructed all around the STP plot (min 810 m length). Boundary Wall having architectural and elegant view shall be provided along entire periphery of the Plot. Height of boundary wall should not be less than 2.0 m from finished ground level. The boundary wall shall be RCC footing & columns and ground beam of M-20 grade including brick masonry in CM 1:4 with wall thickness of

0.23m thick including sand faced plaster on both side with coping of 0.15m thick in M-20 grade with acrylic cement paint, etc. complete as directed by Engineer-In-Charge. It should be able to bear wind pressure up to 80 Km/hr. At least two MS grill gate of 3.60 m wide with frame having weight of gate 30 kg/sqm including hinges, pivot blocks locking arrangement welding riveting and 3 coats of oil painting shall be provided. Each Entry Gate shall be provided with a Wicket Gate.

5.9 Internal Water Supply and Water Supply for Gardening

Proper water facility shall be provided at STP. Rate of water supply may be kept as 150 liter per capita per day for a population of 20 people. Storage should not be less than 3000 litres. Water supply for gardening purpose may be from treated final sewage in sufficient quantity.

5.10 Disposal of Plant Residuals & Treated Sewage

The treated sewage from STP shall be disposed off by the contractor to nearby river. Dewatered sludge from centrifuge shall be a property of employer. However, Disposal of grit and screening shall be done by contractor.

5.11 Landscaping

Landscaping involves beautification of Sewage Treatment Plant site by cultivating lands, plants and trees of environmental value and suitably modifying the appearance of STP site. It shall add scenic value to the STP site to obtain maximum visual impact. Contractor has to develop proper landscaping in the STP site from professional landscaper approved by Employer.

6.0 Interconnecting Piping and Valves

All interconnecting Piping, Gates, Valves, Specials and other appurtenances, auxiliaries and accessories required as per Process Design and Scope of Work. In case of Rising Mains, thrust blocks shall be provided wherever required. In case of buried Pipes, warning tapes shall be provided of the appropriate colours. The material of construction for major interconnecting Piping shall be as follows:

Piping: Guide Line for Velocity

Sr. No.	Service	Design Velocity m/s	Limitations
1	Gravity Lines for Sewage & Water	0.6 - 1.2 Designed as pipe line flowing full.	Min. Velocity shall not be less than 0.6 m/sec. Max. Velocity up to 1.2 m/sec is allowable at Peak Flow.
2	Pressure Lines for Sewage & Water	0.6 - 2.5	Min. Velocity shall not be less than 0.6 m/sec. Max. Velocity up to 2.5 m/sec is allowable at Peak Flow.
3	Air (Pressurized Lines)	18 - 22	Max. Velocity shall not be more than 25 m/sec in any section.
4	Scum & Sludge Lines	0.6 - 1.5	Irrespective of flow, Diameter shall not be less than 150 mm for Gravity Lines.
5	Chemical Feed Lines	0.6 - 1.5	Irrespective of flow, Diameter shall not less than 20 mm.

Notwithstanding the above, the Bidder shall submit a Pipe Line Schedule with Tag No., Flow, Size, Type, Material of Construction etc. with detailed P & ID for approval of the Engineer-in-charge prior to any further engineering or procurement/fabrication and installation.

Generally, the Material of Construction shall be selected based on the following guide lines. The Bidder can make suitable selection depending on Service, Type of Flow (i.e. Gravity or Pressurized) and Diameter of Pipe.

Piping: Guide Lines for MOC

Sr. No.	Service	Type of Flow	MOC
1	Waste Water / Sludge	Gravity	RCC NP-3 Class
2	Waste Water / Sludge	Gravity/Pressurized	CI Class "LA" / DI K-9
3	Service Water	Gravity / Pressurized	GI "C" Class

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Sr. No.	Service	Type of Flow	MOC
4	Air Lines: Headers, Vertical Down-comers	Pressurized	Above Water: MS Sand/Shot Blasted, Epoxy Painted Under Water: SS 304
5a	Air Grid Piping: Aeration Zone	Pressurized	UPVC Schedule 40
5b	Air Grid Piping: Selector Zone	Pressurized	SS 304
6	Chemicals	Gravity / Pressurized	SS 304 except Chlorine & FeCl ₃
7	Chlorine & FeCl ₃	Gravity / Pressurized	Schedule 40 UPVC

Valve: Guide Line

Sr. No.	Service	Type	MOC	End Connection
A	Sewage / Sludge			
1	Gravity / Pressurized	Knife Gate	CI Body & SS 304 Gate & SS 410 Spindle	Flanged/Wafer
2	Delivery of Pump	Swing Check	CS Body & SS 304 Internals	Wafer
3	Suction & Delivery of Pump	Knife Gate	CI Body & SS 304 Gate & SS 410 Spindle	Flanged/Wafer
B	Service Water			
1	Gravity / Pressurized	Ball	CS Body & SS 304 Internals	Flanged/Screwed
2	Delivery of Pump	Swing Check	CS Body & SS 304 Internals	Wafer
3	Suction & Delivery of Pump	Butterfly	CI Body & SS 304 Internals	Wafer
C	Air			
1	Pressurized	Ball	CS Body & SS 304 Internals	Flanged/Screwed
2	Delivery of Blower	Swing Check	CS Body & SS 304 Internals	Wafer

Contractor

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3	Suction & Delivery of Blower	Butterfly	CI Body & SS 304 Internals	Flanged
D	Chemicals			
1a	Gravity / Pressurized	Ball	As per Chemical Compatibility Chart	Flanged
1b	Gravity / Pressurized	Diaphragm	As per Chemical Compatibility Chart	Flanged
1c	Gravity / Pressurized	Plug	As per Chemical Compatibility Chart	Flanged

Notwithstanding the above, the Bidder shall submit a Valve Schedule with Tag No., Flow, Size, Type, and Material of Construction, End Connection etc. with detailed P & ID for approval of the Engineer-in-charge prior to any further engineering or procurement/fabrication and installation.

7.0 Electrical & Instrumentation Works

It shall be the Contractor's responsibility to obtain adequate incoming HT power from State Electricity Authority based on the maximum demand load. The Employer will pay the charges for obtaining the above connection whereas necessary liasoning for the same shall be done by the Contractor in consultation with Engineer-in-charge.

Two nos. of Transformers (1W + 1SB) for full load of the STP and pumping station at STP area with 10% overload shall be provided. These shall be step down Transformers suitable for indoor installation manufactured in accordance with IS 2062/1962 and as modified from time to time. They shall be supplied with all accessories and mounting as per IS 2062 and shall also have Dial Thermometer, Bucholz Relay, Rollers and Explosion Vent. Each Transformer shall be provided with off load tap changer for $\pm 2.5\%$. The windings shall be of connections as per vector group DY II. The efficiency of the Transformer at 100%, 75% and 50% loading should also be indicated separately. The Transformer should be tested as per I.E. Rules & Regulations. Suitable cable boxes for H.T. and bus ducting for L.T. side be provided.

The entire Plant shall be operated on 415 V, 3-Phase, 50 Hz, 4-Wire system. The Contractor's Scope of Work shall include the following:

- Obtaining incoming HT Power from State Electricity Authority including

necessary liasoning, documentation etc. complete.

- HT Cable with Termination Kit from “Source” to the Electrical HT Substation located at the Sewage Treatment Plant.
- HT Substation including 4-Pole Structure, Metering Kiosk, HT Panel, Transformers, Power Control Centre etc. complete.
- Motor Control Centres.
- Cabling including Power, Control and Instrumentation Cables.
- Earthing for Electrical equipments as well as Instruments.
- Internal Lighting in Buildings.
- External Lighting.
- Local Push Button Stations near respective Drives.
- Any other item / accessories required for successful completion of the Project.

The Contractor shall design/execute the System as per standard specifications, I.E. Rules and Regulations, requirements of State Electricity Board and other local Authorities and actual site conditions.

Also, the Contractor shall provide adequate automation for fully automatic operation of the entire Sewage Treatment Plant including Primary Treatment Units, Biological Treatment Units based on SBR technology, Chlorination Tank, Sludge Dewatering Units through a one Programmable Logic Centre (PLC) and Supervisory Control and Data Acquisition (SCADA) with Man-Machine Interface (MMI). Provision shall also be made to operate each Unit of the Plant manually, if required.

9.0 PLC/PC/SCADA BASED AUTOMATION SYSTEM FOR ENTIRE PLANT

The complete Plant shall be designed for automatic operation through Programmable Logic Control (PLC) and Supervisory Control and Data Acquisition (SCADA). This shall be achieved by either individual equipment PLCs with SCADA/HMI or single PLC and SCADA for entire Sewage Treatment including pumping stations. These shall be located at control room of the STP.

The plant shall have provision for operations in following modes -

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1. Automatic - Auto operation through PLC/digital controller.
2. Manual - Operator intervention through SCADA/HMI.
3. Local - Local operation through local control panel located near equipment.

Audio Visual Alarms -

Audio visual alarms shall be initiated under emergency or equipment trip conditions, other than usual service alarms. Salient features of the proposed control system shall be as follows:

- Dynamic display of all Units, equipment and drives shall be available on SCADA screen.
- It shall Acquire, process and manage the processed data.
- It shall safeguard the process by means of interlocks and alarms.
- Auto/Manual operation of each drive shall be made by selecting a soft switch on SCADA/HMI screen.
- In Auto mode, each drive shall operate based on pre-set sequence and interlock. Also automatic change over from working to standby drive shall happen after a drive reaches pre-set hours of operation.
- In Manual mode, each drive shall be operated in Local/Remote mode by selecting a soft switch on SCADA/HMI screen. In Local mode, each drive shall be operated from the Local Push Button Station (LPBS) located nearby. In Remote mode, operation from LPBS shall be disabled and each drive shall be operated manually from PLC. Also provision for working/standby selection of drives by selecting a soft switch on SCADA screen shall be provided.
- Run/Trip indication of all drives shall be displayed on SCADA/HMI screen.
- Open/Close indication of all Auto Sluice Gates and Auto Valves shall be displayed on SCADA/HMI screen.
- Annunciation & Alarm facility shall be available in PLC/HMI/SCADA. In the event of a Fault, the symbol representing the equipment/drive shall continue

flashing on SCADA/HMI screen with equipment/drive description appearing at bottom of the SCADA/HMI screen and electric Hooter shall continue blowing until the Fault Alarm is acknowledged.

- Data logging of Running Hours of each drive, Alarms, Historical Trends of monitored Parameters, etc. shall be envisaged in SCADA.
- Report generation for plant performance.

The process system must have pre-configured software packages which can be adapted to the process by parameterization.

The monitor images must be designed to be user-friendly by hierarchical breakdown with the possibility of selective display and optimum selection possibilities.

Changing of parameters and other software units must be possible "online", i.e. with the system running.

Different alarms colors provide information on their priorities.

For the system engineering offered, the Contractor must take measures, e.g. by the installation of surge voltage arresters or surge voltage filters, to ensure that internal and external surge voltages do not impair the function of his parts of the system.

The programs and data entered must be backed up in a non-volatile read-only memory.

A limit value and plausibility check must be provided in the software of the process station for the measured values and messages. Exceeding of limit values or deviations detected by the above checks must trigger an event and cause a message to be sent.

Further demanded features of the process system:

- Integrated, detailed error message and fault detection concept with display on the HMI/SCADA for quick localization of faults. The system operator must be able to identify the fault from the error.

- Essentially maintenance-free
- Robust against external interferences of all kinds
- Proven design and solder-free connection technique
- Protection of the equipment against surge voltages
- Automatic fault detection and quick troubleshooting in the PLC system by integrated, hierarchically structured diagnostic devices
- Power supply in wide admissible voltage range
- Simple function-oriented operation

The process system (PLC, HMI/SCADA) shall be protected against power failure by an uninterruptible power supply (UPS). When the critical charge state of the UPS is reached, the process system is automatically shut down.

Mode selector switch

A mode selector switch is to be installed on the MCC or distribution board. It serves for pre-selection between Automatic mode and Manual/Local mode.

The following switching functions must be provided:

Automatic - Manual/Local

- Automatic: In this position, only automatic operation is possible; the local switches have no function (Except emergency stop).
- Local: Automatic mode cannot be started. The drives can be operated individually without interlock with the local switches.

Local switches (LPBS)

Each drive must be equipped with a local switch positioned in such a location that the corresponding machine or conveyor can be switched on in Manual/Local mode and can be monitored visually at all times.

The local switch must have the following switching functions:

START - STOP (for drives with one direction of rotation) or

FORWARD - STOP - REVERSE (for reversible drives)

- If a unit has several drives (e.g. conveyor belt drive and travel drive), the local switches should be installed if possible in one switch box or at least installed next to one another.
- Each local switch must be adequately labeled in plain text so that no operator errors can occur.

PLC

The automatic start-up of the whole system, sequential operations and the automatic shutdown, allowing for external control influences, e.g. EMERGENCY STOP, etc., is performed by programmable logic controller (PLC).

This performs not only the control of the system, but also the display of the operating state in the HMI/SCADA.

The interlocks of the individual process groups and their signaling must be performed by the PLC.

A system must be selected which is sufficiently protected against external interference in the supply, control and signaling lines. The aim is that the program can continue to run without fault signals in the event of transient earth faults in the supply grid. In the event of prolonged power failures, on the other hand, a controlled restart must be triggered (under-voltage trip of the non-automatic circuit breaker).

PLC Specifications: Technical

- The PLC shall be non-redundant.
- PLC of individual equipment shall be selected to carry out necessary operations without overloading the PLC memory.
- The PLC shall have adequate I/O per card.
- There shall be 15% spare I/O of each type.
- The CPU shall not be loaded more than 60% of its capacity.
- Retentively shall be 100% to save the recorded data and saving the programmed logic, other attributes connected with system for power & system

failure.

- Change in programme / modifications to programme shall be possible by a portable laptop.
- It is preferred to have all PLC's in the plant from same manufacturer.

HMI/SCADA system

The HMI system shall be designed as a minimum 6", color, touch-screen on the panel. Whereas SCADA system must be computer based.

All displays must be designed by the Contractor with graphic sophistication and all texts in the visualization system must be displayed in English.

A sub-menu for each operating mode and further menus for editing the system parameters, fault archive, etc., must be developed. It must be as simple as possible to switch between the various menus and to edit the system parameters.

When designing the user interface or the assignment of the function keys, attention must be paid that the function key assignment remains the same in all sub-menus so that it is possible to jump to another menu without first having to jump back to the main menu.

It must be possible to edit the following parameters at the touch-panel and SCADA:

- Operating mode
- Changes in the speeds of frequency converter-controlled equipment
- Start-up times
- Shutdown times
- Duration of the operation of warning devices
- Limit values for sensors, etc.

Faults, level messages, pressed EMERGENCY STOP buttons, etc., must also be clearly displayed at the bottom of the screen, irrespective of the selected screen page or sub-menu.

It must be possible to output all important menu items to the printer. The corresponding interfaces must be provided.

The display of the function plans, images, etc. is affected in direct dialog with the

system by means of the mouse and keyboard.

The central SCADA shall generate various reports to analyze plant performance.

The process is documented via the laser printer.

Computer hardware and software

All programs required for operation of the system must be correspondingly compatible. The corresponding licenses must be supplied for the standard programs. The operating systems must be agreed upon with the Client. Minimum requirements shall meet:

CPU		
1.	Processor	Intel i5 or higher
2.	Processor speed	2 GHz or higher
3.	Configuration	Tower
4.	Architecture	32 bit
5.	System memory	8 GB
6.	Hard disk	320 GB or higher
7.	DVD Drive	Combo (Read/Write)
8.	Operating system	Microsoft Windows 7 professional
9.	Communication	USB - 4Nos., Ethernet - 1Nos.
10.	Graphic	1 GB
11.	Power supply	240V, 50Hz, 1Phase
12.	Keyboard	Internet Keyboard (with USB interface)
13.	Mouse	Optical, 3 buttons (with USB interface)
Monitor		
14.	Type	Full HD LED color monitor
15.	Screen size	22" or higher
16.	Resolution	1920 x 1080
17.	Power supply	240V, 50Hz, 1Phase

It shall operate in auto mode. As a minimum, following controls must be considered in Bidder's Control Philosophy:

1. Coarse screens

Each mechanical coarse screen shall be installed with ultrasonic differential level transmitter / level switch, across it; the same shall be operated on the basis of set differential level in SCADA. Also if differential level is not reached for certain time period, the screen shall be operated on the basis set time in SCADA.

The selection of Auto/Manual and Working/Stand-by shall be made available in SCADA. In manual mode the screen operation will be done from SCADA screen. Physical switch over of screens in plant will be done by operator using manual gates.

Necessary interlocks, controls, alarms, report generation, etc. shall be considered in PLC for auto operation of coarse screen.

2. Raw Sewage Sump and Pumps

The sump will employ an Ultrasonic level transmitter to measure level. The combined operation of Raw Sewage Pumps will be dependent on rate of change of level with reference to time. The selection of Auto/Manual and Working/Stand-by shall be made available in SCADA. In manual mode the pump Start/Stop will be done through SCADA screen.

A clamp on type Ultrasonic or Electromagnetic flow transmitter shall be provided at common header of pumps for measurement of flow to sewage treatment plant. PLC shall calculate instantaneous flow as well as cumulative flow, both shall be displayed on SCADA.

Necessary interlocks, controls, alarms, report generation, etc. shall be considered in PLC for auto operation of Raw Sewage Pumps.

3. Inlet chamber

A clamp on type Ultrasonic flow transmitter shall be provided on rising main of inlet chamber for measurement of flow coming to Sewage Treatment Plant. PLC shall calculate instantaneous flow as well as cumulative flow, both shall be displayed on SCADA.

4. Fine screens

Each mechanical fine screen shall be installed with ultrasonic differential level transmitter / level switch, across it; the same shall be operated on the basis of set level in SCADA. Also if level is not reached for certain time period, the screen shall be operated on the basis set time in SCADA.

The selection of Auto/Manual and Working/Stand-by shall be made available in

SCADA. In manual mode the screen operation will be done from SCADA screen. Physical switch over of screens in plant will be done by operator using manual gates.

Necessary interlocks, controls, alarms, report generation, etc. shall be considered in PLC for auto operation of fine screen.

5. Grit Chambers

Each grit chamber will consist of Detroiter (1No.), Organic Return Pump (1No.) and Screw Conveyor for grit removal (1No.). As such Detroiter, Organic Return Pump and Screw Conveyor will not have auto operation; these will be started and stopped from SCADA screen as required.

Necessary interlocks, alarms, report generation, etc. shall be considered in PLC for operation of Grit chamber equipment.

6. SBR Basin

Complete operation and control of SBR plant will be done through a separate PLC and SCADA. However it shall have necessary inputs and generate required outputs to operate in co-ordination upstream and downstream units of balance plant.

Alternatively contractor may provide single PLC and SCADA for entire Sewage Treatment Plant.

Necessary interlocks, controls, alarms, report generation, etc. shall be considered in SBR PLC for auto operation SBR basin.

Each SBR basins shall be equipped with Level Transmitter, DO Transmitter for monitoring and recording of critical operation parameters through SCADA.

7. Sludge sump and pump

An ultrasonic type level transmitter shall be used for measurement of level in sludge sump.

Screw pumps will be used to feed sludge to Centrifuge. These will operate as per level in sludge sump.

The selection of Auto/Manual and Working/Stand-by shall be made available in

SCADA for sludge pumps. In manual mode the Start/Stop of pump will be done from SCADA screen.

Necessary interlocks, alarms, report generation, etc. shall be considered in PLC for operation of chlorination system.

8. Chlorination tank

The selection of Auto/Manual and Working/Stand-by shall be made available in SCADA for booster pumps. In manual mode the Start/Stop of pump will be done from SCADA screen. Though chlorinator will have standalone operation, feedback for the equipment shall be taken to PLC and displayed SCADA for monitoring purpose.

Necessary interlocks, alarms, report generation, etc. shall be considered in PLC for operation of chlorination system.

9. Centrifuge

The drives and instruments of centrifuge shall be connected to PLC for its auto operation. Starting of dewatering system will be a manual process.

Necessary interlocks, alarms, report generation, etc. shall be considered in PLC for auto operation of centrifuges.

2.4 Technical Specifications - Civil Works

a) Survey Work

The Contractor shall carry out detailed survey work and submit both soft and hard copies of contour drawings with spot levels with 10 m x 10 m grid to the Employer. Necessary information such as reference to the location as proposed for the treatment plant by him with respect to site boundary.

b) Geotechnical Investigation

The Contractor shall carry out Geotechnical Investigation work at the proposed location of treatment plant. The no. of bore holes to be taken, depth of boring etc. shall be decided in consultation with the Engineer In-charge. The Contractor has to

provide the hard and soft copies of the test reports. If the bearing capacity of the soil found lower than that is mentioned in the soil report provided with the Tender document, the lower of the two values shall be considered for design.

c) Process / Hydraulics Design

- The Contractor shall provide his own design system and equipment based on Sequential Batch Reaction process to treat the raw sewage up to the sewage quality as said in Clause 3 or even better.
- Bidder shall design the plant in such a way that in case of non-availability of sufficient sewage at the time of commissioning, plant can be commissioned with a minimum quantity of sewage equal to 30% of the average capacity.

d) Treatment Objective

Considering the raw sewage quality and the required treated sewage quality, the Contractor shall furnish a process train to achieve the following objectives -

- To achieve guaranteed treated sewage quality or even better.
- To ensure that the offered treatment process is the most appropriate and state of the art in terms of both efficacy of treatment and cost (the Contractor shall have to produce the performance records with the same treatment systems applied elsewhere.)
- To ensure that the process is cost effective from both capital and running costs consideration.
- To ensure that the sludge produced is dewatered to a “spreadable” or “open body transportable” consistency - so that it can be easily disposed off.
- The process preferably should be free from utilization of chemical/any organic chemicals except for sludge removal process. No toxic chemical shall be used by the Contractor. He will submit the toxicity test report from any govt. recognized laboratory at his own cost before using such chemical.
- Oils/lubes/fuels/media/chemicals etc. to be used will be defined by Bidder.
- The final treated sewage is to be disinfected through chlorination before its

disposal.

e) Structural Design

The Contractor shall have to do the structural design considering the survey details and geotechnical investigation details like safe bearing capacity, seismic forces, depth of water table and hydraulic flow diagram. Rock anchoring shall be carried if required wherever uplift is considered. The design of plant units and Buildings - if any, shall be submitted by the Contractor in soft and hard copies, with General Arrangements and detail RCC drawings. The design of units shall be finalized in consultation with the Engineer - in - Charge. The design of units shall be as per relevant BIS or other Indian/international standards in absence of BIS or sound engineering practice. The requirements to be fulfilled by the Contractor are described in detail in the general civil specifications and particular specifications for civil work for sewage treatment plant. Pressure releasing valve to release sub soil water pressure shall be allowed at appropriate locations.

f) Construction Works

The Contractor shall construct the civil units of the plant (including intermediate process pumping stations wherever required) to accommodate the mechanical units to fulfill the requirement of process design. There shall be adequate working space, accessibility considerations like RCC staircase or ladders, walkway with proper width, hand railing, etc wherever needed. For Buildings, there shall be additional items like ventilation and lighting requirements, flooring and finishing (hard flooring like granite for machine bearing floors) etc. The civil units shall be constructed such that there is proper accessibility for repair or replacement of mechanical equipments. Any concreting shall be done only after approval of Engineer - in - charge. All construction work shall be carried out as per the provision of CPWD specifications unless otherwise mentioned in the document.

g) Equivalency of Standards and Codes

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the

provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the Contract. Where such standards and codes are national or related to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be acceptable subject to the Engineer's prior review and written approval. Differences between standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In fee event the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the Bid Documents.

h) Board

The Contractor at his own cost, shall provide sign boards at approved locations, in English and Hindi at the site of the Works of approved size and design which provides

- (i) The name of the Project,
- (ii) The name and addresses of the Employer, the Contractor and the Consultant;
- (iii) The name and short description of the Project and
- (iv) The starting and completion dates. Contractor shall take care of signboard and re-do it in case of loss, damage, theft etc., as desired by the Engineer In-charge.

i) Assurance Programme/Sample Tests

Contractor shall be responsible to develop a quality control program and to all necessary materials, apparatus, instruments, equipment, facilities and qualified staff for sampling, testing and quality control of the materials and the under the Contractor. Without limiting the generality of the foregoing, the actor shall either

- (i) establish a testing laboratory at the site of Works which be adequately equipped and staffed to carry out all sampling and testing in accordance with the requirement set out in the Tender document specifications provide all field

equipment and apparatus as necessary to conduct all in-situ tests and/or any Tests on Completion, or (ii) arrange for routine sampling, testing and reporting, as required, through a certified independent laboratory acceptable to the Engineer In-charge. The Contractor shall obtain the approval of the Engineer In-charge for the quality control programme developed by him and incorporate any modifications suggested by the Engineer In-charge at no extra cost.

All costs of such sampling, testing and reporting of test results will be borne the Contractor, and the Contractor shall include sufficient provisions in his; tendered rates to allow for independent sampling and laboratory testing under the direction of the Engineer In-charge. The Contractor shall furnish certified copies of all test reports to the Engineer In-charge within 3 days of completion of the specified tests.

The Contractor shall, within 14 days after the date of the issue of Letter of Acceptance, submit to the Engineer In-charge for his consent a detailed description of the arrangements for conducting the quality control programme during execution of the Work, including details of his testing laboratory, equipment, staff and general procedures. If following submission, or at any time during the progress of Works, it appears to the Engineer In-charge that the Contractor's quality control programme is not adequate to ensure the quality of the Works, the Contractor shall produce a revised programme, as desired by the! Engineer In-charge, which will be adequate to ensure satisfactory quality control, in case of the Contractor will fail to ensure quality control program the action deem fit will be taken against the Contractor. The Employer shall carry out supervision and quality control and monitoring the progress of works.

j) Protection of Utilities

The Contractor is required to carefully examine the location of the Works and their alignments and to make special enquiries with all authorities concerning utility lines such as water supply, sewers, gas pipe, telephone (underground and/or overhead) lines, electric cable (underground and/or overhead) etc., and determine and verify to his own satisfaction the character, sizes, position and lengths of such utilities from authentic records. The Contractor shall be wholly responsible for the

protection and/or facilitating relocation of such utilities as may be required and shall not make any claim for extra work or extra time that may be required to protect or facilitate relocating such utilities. If any major shifting realignment of water supply, sewers, gas pipes, electric and telephone lines is necessary due to their interference with the proposed Works, the same may be done by the Contractor. The cost of such relocations will be borne by the Contractor.

k) Erection

Bidders have to note that various major items shall be procured / executed under this Contract subject to inspection by the Employer or their authorized representatives at manufacturer's premises. Cost of inspection shall be borne by Contractor

l) Testing of Concrete

Testing of Concrete shall be carried out as per IS4926: 1976. The contractors shall send three flexural beams to the laboratory for every ten slabs, or part thereof, for testing flexural strength. The admixture used shall conform to IS 9103-1979 reaffirmed on 1990 or AS1 C-494 of 92.

All taxes/duties etc. will be borne by the contractors and not by the Employer. No extra payment will be made for the use of admixtures.

2.5 Mechanical Equipments for STP

The Contractor shall have to design, supply, erect and commission the mechanical equipments as proposed by him in the treatment train to achieve the required parameters. The design, material of construction and type of various mechanical equipments shall conform to the standards laid in various sections of Tender document.

2.6 Electrical and Instrumentation / Automation System

The Contractor shall design, shop test, supply, transport, storing at site, erecting, testing and commissioning all electrical equipment and instruments required for the plant as per general specifications, specific specifications for electrical works, typical power distribution scheme and typical control system architecture.

2.7 Disposal of Sludge/Screenings/Debris

The screenings/debris/dried sludge from the Sludge Handling Unit shall be disposed off by the Contractor to a suitable location, which is away from the residential area. The place of sludge disposal shall be as per the decision of the Engineer In-charge, within a radius of kms from the plant. The responsibility of sludge withdrawal and disposing off lies with the Contractor within the operation and maintenance period. The Contractor should explore the possibility promoting it as manure.

2.8 Disposal of Excavated Stuff

It will be the responsibility of Contractor to dispose all the excavated stuff within the Employer limits as directed by Engineer In-charge.

2.9 General Utilities

For the proper functioning of the proposed works of sewage treatment plant, connection for rising mains, sewage channel, the other general utilities necessary for the proper functioning of the proposed works which shall be included under this Contract are :

- Internal & outdoor lighting, plant water supply and sanitation, waste disposal, etc.
- Electric substations and distribution of power supply to all necessary points
- Street and yard lighting and fire hydrant system for the STP.

2.10 Safety Equipment:

Safety Equipments should be provided at STP as per the recommendation of Inspector of Industries. Contractor shall also take care of safety compliance as applicable from time to time as per safety rules/Factory act/Indian Electricity regulations/manuals/manufacturers special instructions.

2.11 Model of the Project:

A 3D Model of the Plant shall also be submitted by the Contractor. The size of the Model shall not be less than 1.5 m x 2.5 m. The Model shall be within a wooden

Box having glass on its top and kept over a Table for display.

2.12 Scope of Work for Operation & Maintenance

The Bidder shall operate and maintain the Raw Sewage Pumping Stations, Sewage Treatment Plant and all other allied works under this Contract for a period of 60 months, including defect liability period of 60 months. For this period, the scope of work shall include, but not be limited to the Operation and Maintenance of the following:

- Raw Sewage Pumping Station and Sewage Treatment Plant including all the Civil Units and Electro-Mechanical Equipments as per the Bidder's Proposal to ensure that all the output guarantees are met.
- General Facilities and Utility Services.
- PLC/SCADA based Automation system.
- All other in-plant facilities listed in the detailed Scope of Work

The Bidder shall also dispose-off the sludge, screenings, grit and any other material, as per specifications and to the satisfaction of the Engineer In-charge. It is to be noted that all costs during the O&M period excluding cost of power and diesel for DG is to be borne by the Contractor. Within his quoted cost, the Bidder is to ensure that the following guarantees are maintained:

- Guarantee for Quality of Treated Sewage.
- Guarantee for Power Consumption.
- Guarantee for Automation System.

The Bidder shall provide on job training to the Employer staff as per specifications.

The Bidder shall, at no extra cost to the Employer, repair and re-condition all the required mechanical equipment in the concluding year of the O & M period and Hand over the facility to the Employer in proper & fully working condition.

2.13 Operation and Maintenance Cost

All the cost for Operation and Maintenance of the Plant such as Chemicals and Consumables, Disposal of Screenings, Grit and Dewatered Sludge, Manpower,

Spares, Repair and Maintenance of Civil, Mechanical, Electrical, Instrumentation Items including all other major/minor repairs, breakdowns, replacements etc. **excluding Cost of Electricity and Diesel for DG** shall be in the scope of the Bidder. **No extra payment other than whatever has been quoted in Price Schedule will be entertained by the Employer.**

The Bidders are to quote O&M Cost and provide Functional Guarantee based on the design parameters given in the tender which shall be used for technical evaluation of qualifying Bids:

2.14 Contract Period

The total Contract Period shall be as follows :

Construction Period	:	18 Months (Including Monsoon)
Performance Run	:	3 Months
O&M Period	:	60 Months including 60 months defect liability period

TESTING & COMMISSIONING

TEST ON COMPLETION

General

Prior to the commencement of Tests on Completion the Contractor shall submit for approval

the following:

- Site Acceptance Test Documents for STP & SPS.
- As-Built Drawings STP & both SPS.
- Operation & Maintenance Manuals STP & SPS.

Tests on Completion shall not be commenced until the aforementioned documents are

approved.

The initial charges necessary for Tests on Completion shall be provided by the

Contractor.

Electricity required for Tests on Completion will be provided by EMPLOYER free of charge for a

period not exceeding 30 days. In case the test on completion period exceeds 30 days, the cost of power till start of performance run shall be borne by contractor.

The cost of any consumables and chemicals required for the Tests on Completion shall be

borne by the Contractor.

Dry Test Requirements

General

As a minimum requirement, the following dry tests shall be carried out as a general requirement:

- a general inspection to check for correct assembly and quality of workmanship,
 - a check on adequacy and security of Plant fixing arrangements
 - a general check to ensure that all covers, access ladders, water-proofing, guard railings
- etc. are in place,
- a check on damp proofing, rust proofing and vermin proofing and particularly the sealing

of aperture between building structure , chambers, etc. and the outside.

Civil and Building Works

As a minimum requirement the following dry tests shall be carried out on the civil engineering

and building works:

Check for the presence of foreign bodies in pipe work and structures.

Mechanical Works

As a minimum requirement the following dry tests shall be carried out on the mechanical

systems:

- Carry out preliminary running checks as far is permitted by circumstances in order to ensure smooth operation of Plant.

Check for the presence of foreign bodies in wet well, delivery pipe and rising main.

Electrical Works

As a minimum requirement the following dry tests shall be carried out on the electrical

systems:

- Check phasing and polarity
- Carry out point to point check on all cables;
- Check on security of cable terminations
- Check on completeness and adequacy of earthing systems;
- Check setting on protection relays, sizes of fuses and motor overload settings;
- Carry out checks on cabling systems in accordance with the requirements of the relevant

standards;

- Check operation of main circuit breakers by secondary injection methods;
- Check rotational direction of plant;
- Check instrument loop integrity, functionality and calibration;
- Check operation of standby generator installation and mains/generator changeover

procedures; a 4 hrs load test (using the normal load of the Works) shall be carried out

on the generator when the load is available;

- Check plant functionality
- Check functionality of the central MMI and its power supply;

Process STP & SPS Item / Equipment

All process plant items/equipment shall be tested to ensure they meet the Employer's

Requirements for quality of workmanship, construction and performance.

Hydraulic Wet Test Requirement

Hydraulic wet tests shall be carried out on completion of dry tests.

Potable water shall be used for hydraulic wet tests. The purposes of the tests is to prove as far as is practical the hydraulic performance of the Works. In order to demonstrate this Contractor shall ensure that each part of the Works is hydraulically loaded to its maximum rated load throughout for a period of at least seven days at twenty-four hours intervals.

In order to ensure a sufficient supply of potable water to carry out these tests the Contractor

shall provide facilities for the disposal off site in an approved manner.

In order to remove doubt the following tests inter alia shall be carried out.

- Pressure testing of all piped systems laid direct in ground in accordance with the relevant

standards;

- Fill all structures and check for leaks as per IS:3370;
- Running of all pumped systems in order to check for
- Correct functionality
- Absence of leaks
- Correct running temperatures
- Smoothness of running and the absence of undue vibration or stress;

- Check drive running currents
- Carry out calibration of instruments where appropriate
- Carry out valving, diversion etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element;
- Demonstrate correct functionality of electrical, control and instrumentation systems.

The Contractor shall simulate where practical the conditions that will prevail when operating as a process in order to demonstrate the correct functionality of process control loop etc.

During these tests a check on the performance of Plant shall be made, as far as site facilities

will allow, to compare its site performance with the factory test data and to identify and

constraints on performance due to site conditions.

Process Wet Test

On approval by the EMPLOYER the Contractor shall carry out process wet tests.

Raw water shall be used as the primary feed stock for process wet tests. These tests shall be

carried out to demonstrate the process performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is located to its rated throughput

(including a period of overload if required in order to demonstrate compliance with the Employer's Requirements) for continuous stable operating period of not less than 48 hours. The Contractor shall provide facilities for the disposal off site in an approved manner.

The following tests inter alia shall be carried out;

- Check and rectify leakage on civil structures, pumps and pipework;
- Running of all pumped systems in order to check for;
- Correct functionality,
- Absence of leaks,
- Correct running temperatures,
- Smoothness of running and the absence of undue vibration or stress,
- Check drive running currents where the solution pumped is different from that pumped

during hydraulic wet tests;

- Carry out calibration of instruments;
- Carry out valving, diversion etc to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element;
- Demonstrate correct functionality of electrical, control and instrumentation systems not

checked during dry or hydraulic wet tests or which may have changed as a result of the

different operating conditions now prevailing.

- On completion of process wet test on the various parts of the works the Contractor shall

run the plant as a whole in order to demonstrate the full functionality and performance of the Works at various throughput rates for a continuous period of not less than 7 days. In this period power utilized by the contractor shall be compared with the guaranteed power consumption given by the contractor. This shall be considered as completion of 'Test on Completion' and shall be certified by EMPLOYER.

PERFORMANCE RUN AFTER START UP

General

On successful completion of 'Test on Completion' i.e. Start up and commissioning, certified by EMPLOYER, Contractor should start the performance run of the plant for 3 months.

The Contractor is to carryout Operation & Maintenance (O&M) of the whole plant including

civil works for 3 (three) months under performance run. EMPLOYER shall monitor the operation and

maintenance by the Contractor.

During performance run period, the Contractor shall provide following as minimum for round

the clock operation.

Sr. Personnel	No. Total	Experience	Main Task of the Personnel
1 Plant In Charge (BE Civil/Environment) satisfactory	1	5 years	Coordination of activities for performance of the STP & pumping station and reporting to the Engineer-in-charge and responsible for the proper functioning & maintenance, data collection of STP & pumping station.
2 Operators (Diploma, ITI Qualified) operation for STP	6	3 years	Responsible for overall and pumping station.
4 Electrician (ITI Qualified) of electrical	1	3 years	Responsible for maintenance equipment.

5 Fitter (Mech.)

(Diploma, ITI
Qualified)

1

3 years

Responsible for maintenance

of mechanical equipment.

6 Helpers

6

1 years

Responsible for keeping

the STP premises

clean and neat. Also they will assist
operators in day to day activities.

6 Security Guards

4

1 year

To protect the plant from the

trespassers,

animals etc.

7 Gardener

1

5 years

To

maintain

the

garden/landscaping of the

plant

8 Sweeper

1

5 years

Assisting in day to day activities in

office,

keeping office clean & neat.

Spares: As required for replacement during performance run period. The spares used from the spare supplied under the contract shall be replaced by the Contractor.

EMPLOYER shall supply power and water during Performance Run period free of cost. All other material such as chemicals, consumables, lubricants, tools & plants, spares etc shall be provided by the contractor. The contractor, if required, shall provide activated sludge or any other material for the stabilisation of the plant.

The Contractor shall provide operators for various units/plants for three shifts and other

staff/supporting personnel in general shift.

The Contractor shall submit a weekly report to the Employer, about the operation and

maintenance indicating the manpower, electric power, chemicals and other consumables

consumed and also problems faced and rectified.

During this period, the Contractor shall ensure that the design treated sewage quality standards are met in accordance with the specification within the rate of

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power and chemical consumption as committed by the Contractor. The raw and treated sewage analysis pH, SS, BOD and oil & grease shall be carried out on daily basis from the day of commissioning at a reputed laboratory as approved by Engineer-in-Charge. 90% of the treated sewage samples should fall within prescribed limits of the treated sewage. The sampling location for raw sewage shall be at raw sewage sump and that of treated sewage shall be at outlet of chlorine contact tank. The analysis of sewage for the above parameters at different locations such as outlet of

secondary clarifier shall also be carried out on weekly basis. The Contractor shall take

immediate steps to correct the operation of the plant to meet the guaranteed performance. The charges for analysis at the laboratory are to be borne by the Contractor.

The Contractor's responsibility includes the safety and security of the works/plants during the

course of performance run of three month.

The Contractor shall provide the key personnel for performance run with the minimum

qualification and experience as given below.

Sr.	Category	Qualification and Experience
1.	Plant in charge Environmental	Graduate in Engineering/Technology (Civil/Engineering) having 5 years of experience in O & M/ Maintenance of water /wastewater treatment plant.
2.	Plant Operator Environmental/	Diploma in Engineering/Technology (Civil/Chemical Engineering) having 3 years of experience in Operation/ Commissioning of water/wastewater treatment plants.
3.	Chemist years of	Graduate in Environmental Science/ Chemistry having 5

wastewater treatment

experience in sampling/ analysis in water /
plants.

4. Electrician / Fitter Diploma in respective field with 5 years of experience in erection, commissioning and O&M of M&E equipment in water/ wastewater treatment plants.

PERFORMANCE RUN CERTIFICATE

The conditions for issuance of a Performance Run Certificate as detailed in the Conditions of

Contract shall comprise:

- The completion of the three months operation and maintenance under performance run
of the treatment plant to the satisfaction of EMPLOYER.
- 90% of the treated sewage samples fall within the prescribed limits of the treated sewage
as mentioned in the tender document.
- The O & M Manuals have been updated following three month's operational experience
and approved by EMPLOYER.
- All defects identified during the three months operation of the works have been rectified
- EMPLOYER shall issue a Completion Certificate for "Performance Run of Plant" after successful completion of Performance Run of plant for 90 consecutive days by Contractor to the satisfaction of EMPLOYER.

SCOPE OF WORK - OPERATION & MAINTENANCE

1.0 General Obligations

The Bidder shall during the O&M Period, undertake all services relating to operation and maintenance of the Project Facilities in conformity with O&M Requirements.

- a. The Bidder shall submit to the Engineer-in-charge a plan for operation and maintenance of the Project Facilities ("O&M Plan") in conformity with the

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Construction Requirements, O&M Requirements and Performance Standards as set out in Tender Document after the completion of the construction period.

- b. The O&M Plan shall set out in detail the standards, schedules, procedures, type, periodicity and other details of the operation and maintenance activities to be carried out for the Project during the O & M Period so as to meet the O&M Requirements as well as details of the management information system to be incorporated, reports to be submitted and procedure for reviews, including developing a mechanism for corrective actions.
- c. Engineer-in-charge shall review the same and convey its comments/observations to the Bidder on the O&M Plan, including the need, if any, to modify the same. If the comments/observations of the Engineer-in-charge require the O&M Plan to be modified, the Bidder shall suitably modify the O&M Plan. The O&M Plan shall be finalized with mutual consent.
- d. Notwithstanding any review or failure to review by the Engineer-in-charge or the comments/ observations of the Engineer-in-charge, the Bidder shall be solely responsible for the adequacy of the O&M Plan and the conformity thereof with the Performance Standards, Construction Requirements and O&M Requirements and shall not be relieved or absolved in any manner whatsoever of any of its obligations hereunder.
- e. The Bidder shall inform engineer-in-charge details of its key personnel responsible for O&M and subsequent changes, if any, from time to time. However minimum manpower as given in the tender document shall be provided for the Operation and Maintenance of the project at all times.
- f. The Bidder shall undertake operations and maintenance of the Project Facilities by itself or through Contractor possessing requisite technical/financial/managerial expertise/ capability, but in either case, the Bidder shall remain solely responsible to meet the O&M Requirements.
- g. The Bidder shall incorporate good management practices and appropriate technologies required for meeting the Performance Standards.
- h. The Bidder shall, during the Agreement Period;
 - (i) have requisite organization and designate and appoint suitable officers / representatives as it may deem appropriate to supervise the Project, to deal with

the Engineer-in-charge and to be responsible for all necessary exchange of information required pursuant to the tender provisions; Minimum Manpower as required for the plant operation and maintenance as per the Tender Document shall be provided at all times.

- (ii) for the purposes of determining that the Project Facilities are being maintained in accordance with the Construction Requirements and O&M Requirements, the Bidder shall with due diligence carry out all necessary and periodical Tests in accordance with the instructions and under the supervision of the Engineer-in charge Bidder shall maintain proper record of such Tests and the remedial measures taken to cure the defects or deficiencies, if any, indicated by the Test results.
- (iii) conduct all Tests / guaranteed trial runs to ascertain compliance with Construction Requirements and O&M Requirements.
- (iv) suspend forthwith the whole or any part of the O&M activities upon receiving a written notice from the Engineer-in-charge who may require the Bidder to suspend the activities in whole or part if in the reasonable opinion of the Engineer-in-charge, the operations are being carried on in a manner that is not in conformity with the O&M Requirements.
- (v) be responsible for the security of the Project facilities and comply with all applicable laws, statutory requirements as may be applicable from time to time.
- (vi) be responsible for the routine as well as any capital replacement that maybe required either to meet the agreed specifications and performance of the Project facilities.
- (vii) The Bidder shall as per pre agreed format record the system performance and periodically provide the same to Engineer-in-charge.

1.1 Other Obligations during O&M stage

The Bidder shall:

- a. from the Date of commissioning, undertake all services relating to Development, operation and maintenance of the plant in conformity with O&M Requirements.
- b. and shall meet its Performance Standards as per the Tender Document and all statutory laws as applicable.
- c. From the Date of commissioning, carry out the following activities in the

Project Area:

- Ensure that treated sewage is recycled and used within the plant battery limits for various non-human consumption activities to the extent possible.
 - Obtain the desired Performance parameters from the plant, such that it is necessary that each unit's treatment process is operated and maintained to function at optimum level and the process parameters to be maintained at each unit of treatment plant is closely monitored.
- d. The Bidder shall Operate & Maintain the Project facilities with the following scope of work:
1. For a period of 60 (Sixty) months from the date commissioning.
 2. Treat Raw Sewage to desired treatment standards and with the treatment process specified in the Tender Document.
 3. Supply of necessary chemicals and consumables as required for treatment specified in the Tender Document under functions and responsibility of the Bidder.
 4. Provide the qualified staff required including security for watch and ward, necessary skilled and trained men for preventive and breakdown maintenance of all the equipment's and components of the Project facility.
 5. Cost of all repairs i.e., major and minor to all the equipment's, plant and machinery, electrical and mechanical equipment's, instrumentation and civil works etc.
 6. Cost of all spares/replacements to all the equipment's, plant and machinery, electrical and mechanical equipment's, instrumentation and civil works etc.
 7. Cost of all labor, materials, special tools and ordinary tools and parts required for maintenance of all equipment's.
 8. Supply of engine oil, lubricants, necessary spare parts.
 9. Cost towards salary of staff, guidance and training of staff, monitoring of the treatment process by Public health engineer as specified.
 10. Carrying out Raw and Treated sampling, testing, according to the standard test procedures.
 11. Cost of necessary chemicals reagents, and glass ware for testing the samples by the chemist employed including monitoring and control of treatment

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process and ensuring that the raw sewage is treated in accordance to the performance standards prescribed in Schedule - 7.

12. Maintaining log books/ registers for daily inputs and outputs , flow rates, quality test results , chemicals consumed , energy used, staff attendance , preventive and break down maintenance works done for each equipment and other plant O & M data etc.
13. Maintaining gardens, trees, roads and drains in the plant premises and keep the Project Facility / Project Area and equipment's in good working conditions conforming to all the requirements set out under this Agreement.
14. Any other item left out and necessary as per guidelines of statutory agencies will be carried out within scope of above work.
15. Take necessary action as may be appropriate and in accordance with Prudent Utility Practices in the event of an emergency or risk of danger or damage to persons or property (including the Project Facilities).

1.2 O&M Cost Obligations

The Bidder rate quoted by him in the Price Bid shall include following O&M Cost obligation with other contractual obligation within the Project Area.

- a. Water usage cost
- b. Establishment cost
- c. Chemicals & other consumables cost
- d. Manpower for Plant operation
- e. Maintenance & repairs / replacement of Project facility.
- f. O&M obligation under this Contract unless excluded by this Contract.
- g. All expenses towards Statutory permissions
- h. Any other expense required for upkeep and smooth operation of the Project Facility.

1.3 General activities during O & M period

During O & M Period of 60 months, contractor shall perform, not limited but including, following general activities:

1. Operations

a. Daily Operations of Facility

The Contractor shall carry out all facility operation and waste water conveyance, treatment & disposal operations indicated below; in accordance with Good Operating Practices, as set out in this Contract. The Facility operation and waste water disposal operations shall include, but not be limited to the following:

- Operating & Maintaining Raw Sewage Pumping Station.
- Operating & Maintaining Sewage Treatment Plant to maintain the quality of treated sewage within the standards prescribed in the Tender, operate electrical equipment during power failures by operating generators and operate Sludge Handling units.
- Carrying out continuous flow measurements of treated & untreated sewage and recording the same online / offline.
- Collecting samples of influent and effluent and analyzing them daily to determine the quality of sewage and performance of the treatment plant and Providing security for facilities and system at all times.

b. Contingency Plan

Developing and implementing contingency plans in respect of responses to natural disasters, periods of power failure, storm water inflow into sewers during monsoon, de-silting of units of treatment plants, constraint operations or other similar emergencies to maintain the quality of treated sewage.

c. Energy Audit

The Operator shall take all necessary measures to minimize the power consumption in carrying out its operations. The energy audit operations shall include, but not be limited to the following.

- Reducing electricity consumption by regulating equipment operation through suitable modifications to the operating schedules.
- Maintaining power factor and demand to avoid penalty

- Installing more efficient pumping equipment and following better maintenance practices for electrical installation.

d. Repairs and Maintenance

The Contractor shall carry out preventive, routine maintenance and breakdown maintenance Operations for proper upkeep of plant in accordance with good operating practices. The following items shall be included in such maintenances.

i) Machinery and Treatment Plant Equipment

- Dewatering and de-silting of sludge Sump, chlorination Tank, chemical dosing tanks at least twice a year as per approved programs and disposal of silt.
- Cleaning and maintaining all rising mains/sewers in the plant area at least four times a year.
- Repairing and replacing damaged pipes, fittings and valves for suction and delivery pipe.
- Repairing and replacing pump impellers, body, bearings shafts column pipes.
- Repairing and replacing motors
- Repairing and replacing starters, circuit breakers, capacitors
- Repairing and replacing vanes and/or gears of agitators
- Repairing and replacing transformer.
- Repairing of blowers, decanter, diffusers, chlorinator, chemical dosing equipment's & Centrifuges.

ii) Building and Civil Structures

- Water proofing leaking roofs of the Buildings.
- The preventive and routine maintenance shall include all repairs and provision of spares material and tools required for these repairs. The Contractors shall also carry out breakdown maintenance and repairs. The labour, tools and plant, spares shall be arranged by the Contractor. The following spares shall be the respective responsibility of the Contractor and the Employer during preventive routine and breakdown maintenance.

10. 2. Advice Early Warning:

The Contractor is to warn the Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the operations or the condition of the facilities and / or system. The Contractor shall cooperate with the Engineer in making and considering proposals for how the effect of such an event or circumstances can be avoided or reduced and in carrying out any resulting instruction of the Engineer

The Contractor shall also advise the Employer from time to time, on improving the quality of operations, reduction in water / energy losses and betterment practices.

11. 3. Reporting

The Contractor shall utilize the office space, provided by the Employer to establish its monitoring and reporting office along with computer and peripherals. It shall also obtain a telephone connection and maintain the same through the Contract period. All data transfers and updates made to the Employer shall be affected through the said telecommunications medium.

The Contractor shall carry out all reporting indicated below and as set out in this Contract. The reporting shall include, but not be limited to the following.

- Daily summary of Operations at Sewage Treatment Plant - A daily report of operation of the diffuses, agitators, decanter and other equipment at the sewage treatment plants providing information on the quantity of sewage treated, hours of operation of equipment, energy consumed and use of chemicals.
- Sewage Quality Monitoring - A daily report monitoring the quality of raw and treated sewage through the analysis of samples.
- Sewer / Storm Water Drains / wet well & other units etc. Monthly cleaning report sewer / storm water drain de-silted and record of silt disposed at disposal sites.
- Continuous flow measurements of Raw & Treated Sewage and recording the same.

12. 4. General Responsibilities

The Contractor shall maintain properly and keep intact all assets / works/facilities / system of the Employer throughout the Contract period and shall hand over the same in good working condition at the end of the Contract. The Contractor shall not modify or alter any operations regarding the facilities and / or system without prior written permission of the Employer or its representative.

The Contractor shall procure all spare parts required for the maintenance of equipment excluding those to be supplied by the Employer. The Contractor shall warrant to the effect that all the spares shall be procured from the authorized sources and be of the best quality and fit for the purpose for which it is being used.

The Contractor is expected to carry out the work in such a manner as not because any damage to public property on account of negligence or otherwise. The Contractor shall be fully responsible for making good the damages so caused by him entirely at his own cost.

The assets / works / facilities / systems of the Employer shall be at the risk and in the sole charge of the Contractor and it shall be responsible for making good any loss or damage there to arising from any cause whatever including that due to a theft or robbery.

The Contractor shall provide adequate engineering equipment, maintenance staff, inventories plant and machinery and all other things, whether of a temporary or permanent nature required for carrying out operations under the Contract.

The Contractor shall carry out its Operations, so far as compliance with the requirement of the Contract permits, so as not to interfere unnecessarily or improperly with:

- The convenience of the public
- The access to use and occupation of public or private roads and footpaths to or of properties.

Permissions: The Contractor shall obtain all required permissions, sanctions clearances and permits for carrying out its Operations, including Contractors clearances and shall be fully responsible for carrying out the operations in a safe and secure

manner, consistent with the law of the land, laws and regulations regarding such facilities and / or System and directives of any Authority and planning permissions.

Safety: The Contractor shall be responsible for the safety of all activities on the site and shall be absolutely and solely responsible for any and all kinds of injuries or damages to persons and property of any description whatever may be caused by or result from the operations carried out, whether these may have been carried out skilfully and carefully and strictly in conformity with the provision of the specifications or not.

Discoveries: All fossils, coins, articles of value or antiquity and structures and other remains or things of geological or archaeological interest discovered on the Site shall as between the Employer and the Contractor, be deemed to be the absolute property of the Employer. The Contractor shall take reasonable precautions to prevent its workmen or any other persons from removing or damaging any such article or thing and shall, immediately upon discovery thereof and before removal, acquaint the Engineer of such discovery and carry out the Employer instructions for dealing with the same.

The Contractor shall be responsible for payment of reinstatement charges for roads, footpaths and land as per the Employer's rates.

The Contractor shall take full responsibility for the adequacy stability and safety of all Site operations.

5. Staff & Labour:

A. Engagement of Staff & Labour

The Contractor shall employ skilled, semi-skilled and unskilled labour in sufficient numbers to carry out its operations at the required rate of progress and of quality to ensure workmanship of the degree specified in the Contract for timely fulfilling of the Contractor's obligations under the Contract and to the satisfaction of the Employer.

The Contractor shall not employ in connection with the operations any child who has not completed his/her fifteenth year of age. It shall also not employ an adolescent who has not completed his / her eighteenth year unless he/she is certified fit

for carrying out operations as an adult as prescribed under clause b) of such section (2)(of Section 69 of the factories Act 1948.

The Contractor shall provide its staff, a minimum of two sets of uniforms with the titles the Employer inscribed on the back and subject to approval of the Employer. Each worker on duty shall wear a clean uniform whenever on duty.

The Contractor shall be required by the Engineer deliver to it, to such forms and at such intervals as the Engineer may prescribed a return showing the numbers of the several classes of staff employed by the Contractor on the site and such other information as the Engineer may require.

If the Employer asked the Contractor to remove a person who is a member of the Contractor's staff stating the reasons, the Contractor shall ensure that the person leave the site within seven (7) days and has no further connection with operations under the Contract.

At all times during continuance of the Contract, the Contractor and its sub-contractors shall abide by all existing and future labour enactment and rules made there under, regulations, notifications and bye-laws of the Central, State or Local Government. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by any Authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments.

If the Employer is caused to pay or reimburse such amounts as may be necessary to carry or observe, or for non-observance of the provisions stipulated in the notifications/bye-laws/acts/rules/regulations including amendments if any, on the part of the Contractor and in connection with labour enactment, the Engineer shall have the right to deduct any money due to the Contractor including its amount of security deposit. The Engineer shall also have the right to recover from the Contractor, any sum required or estimated to be required for making good the loss or damage suffered by the Employer.

B. Contractor's Superintendence

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The Contractor shall provide all necessary superintendence while carrying out its operations and as long thereafter as the Employer may consider necessary for the proper fulfilling of the Contractor's obligations under the Contract. The Contractor shall nominate a competent and authorized representative (Contractor Representative) approved of by the Engineer which approval may at any time be withdrawn. The Contractor's Representative shall give its whole time to the superintendence of the operations. The Contractor's Representative shall receive, on behalf of the Contractor, instructions from the Engineer which shall be deemed received by the Contractor.

13. 6. Repairs and Maintenance Schedules

14. 1. Sewage Treatment Plant Complex:

As per indicated period checking the operation, correcting defects, attending to calibration and setting is required attending to minor repairs and proper up keeping) such as cleaning and painting) required for the following :

15. i. Monthly

- Roof and surroundings and
- Lightning arrestors.

ii. Annual

- Leakages in structures
- Ladders
- Railings
- Structural damages to the wet and dry well and
- Overflow drain.

16. 2. Pumping Machinery and Treatment Plant Equipment:

As per indicated period checking the operation, correcting defects attending to calibration and setting is required attending to minor repairs and proper up keeping) such as cleaning and painting) required for the following:

i. Daily

- Screens/ Grit Channels

- Moving parts of screens and grit removal equipment, Blowers /Agitators / Pumps/ Agitators /Return Sludge pumps/ Chemical mixer/Centrifuge/Decanter
- Stuffing box
- Bearing and
- Cable insulation near the lugs.
- Panels Breaker and Starter
- Contacts of relay and circuit breaker and
- Setting of over-current relay, no-volt coil and tripping mechanism and off in the dash pot relay.
- Transformer Sub-station
- Ground Operated Dis-connectors (GOD)
- Contacts of GOD and of Over Current (OC) relays
- Radiators and Earth pit

ii. Monthly

- Screens and Grit channels
- Chains in mechanically operated components
- Screens performance
- Transformer
- Relay alarm circuit
- Load (Amperes) and
- Voltage

iii. Quarterly

- Transformer
- Bushing and
- Dehydrating breathers

iv. Half -Yearly

- Pumps / Blowers /Agitators / Compressor /Decaners/Centrifuge
- Gland of stuffing box
- Gland bolts
- Gland packing

- Alignment of pump aerator and drive and
- Oil lubricated bearings
- Motors
- Tripping elements for motor protection
- Contact points and
- Fuse ratings
- v. **Annual**
- Paint screens, grit removal mechanism, scrapers, scrapers , motors, pipes,
- Valves, fittings agitators and inlet/outlet weirs with two coats of anticorrosive paints.
- Replace worn out parts of mechanical equipment in sewage treatment plant.

17. 3. Buildings and Civil Structures:

Carry out routine maintenance and minor repairs including cleaning, repairs to plaster, doors, windows and painting.

i. Daily

- Sweep the premises
- Clean the floors and parts inside the Building
- Clear the cobwebs and other biological growth
- Maintenance of horticulture
- Disposal and transportation of dewatered sludge

ii. Half - Yearly

- Repair damaged floor, plaster, roof, leakages and
- Repair damaged doors, windows and other fixtures.

DESCRIPTION OF STAFFING

Details of minimum staff required to be employed for the operation and maintenance of the

sewage treatment plant for 60 months is given below. However, additional staff, if required for proper operation and maintenance of STP, will be provided by the contractor without any additional charges.

Sr. Personnel	No.	Total Experience	Main Task of the Personnel
1 Plant In Charge (BE Civil/Environment) factory	1	5 years	Coordination of activities for satisfactory performance of the STP & pumping station and reporting to the Engineer-in-charge and responsible for the proper functioning & maintenance, data collection of STP & pumping station.
2 Operators (Diploma, ITI Qualified) STP and pumping station.	6	3 years	Responsible for overall operation for
4 Electrician (ITI Qualified) equipment.	1	3 years	Responsible for maintenance of electrical
5 Fitter (Mech.) (Diploma, ITI Qualified) equipment.	1	3 years	Responsible for maintenance of mechanical
6 Helpers clean and operators in day to	6	1 years	Responsible for keeping the STP premises neat. Also they will assist day activities.
6 Security Guards passers, animals etc.	4	1 year	To protect the plant from the tres-
7 Gardener of the plant	1	5 years	To maintain the garden/landscaping
8 Sweeper office, keeping office clean & neat	1	5 years	Assisting in day to day activities in

GENERAL SPECIFICATIONS

Contractor

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TECHNICAL SPECIFICATIONS - E & M WORKS

1.1 GENERAL

All the E&M works shall be carried out as per latest CPWD Electrical Specifications Part - I (Internal) - 1994, Part - II (External)-1995, Part-IV (Sub-Station) - 1982, Part - VI (Fire Alarm System) - 1988 & Air Conditioning - 1997 with up to date corrections slips issued up to the date of submission of bid. In case the CPWD specifications are not found applicable and adequate than the relevant BIS specifications shall be used. Further in case, any of these are not applicable to particular tools, Equipments and machinery, then the manufacturer's specifications or their relevant instructions shall be followed.

1.1.1 Lighting System

1.1.1 Drawings and Data

- a) 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.
- b) 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

1.1.1.2 General Requirements

The Lighting system includes the following items:

- (i) Lighting fixtures complete with Lamps and accessories
- (ii) Lighting system equipment
 - Light control switches, receptacle units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system
 - Lighting fixture supports and street lighting poles
 - Lighting main distribution board, lighting panels.
- c) Multi core cables for street, boundary and flood lighting

1.1.2.3 Design Requirements

It shall be responsibility of the contractor to work out a detailed layout 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.

The design, manufacture and performance of equipment shall conform to the latest amended Indian standard and following design and general criterion is given in Volume - I, Section - 2.0 Scope of Work above.

Mechanical Equipments:

Ambient Air Temp : Max. 45° C
Min. 2° C
Relative humidity : Max. 85%
Min. 15%

Electrical Equipments:

Ambient Air Temp : Max. 45° C
Min. 2° C
Relative humidity : Max. 85%
Min. 15%

Nominal system supply

1. Incoming power : 11KV, 3Ø, 3W, 50Hz
2. Power distribution : 11KV/ 415V, 3Ø, 4W, 50Hz, AC
3. Lighting & space heating : 240V, 1Ø, 2W, 50Hz AC
4. D.C. Controlling : 30V and 24V D.C
5. A.C. Control : 240V A.C
6. P T Secondary : 110V, 3 Phase, 50 Hz A.C

7. Variation

Voltage : ± 10%,
Frequency : ± 5%
Combined Voltage and Frequency : ± 10%,

8. System Earthing:

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- a) 11KV System : Wherever generation is taking place at 11 KV, this will be earth through resistance.
- b) 415V system : Neutral solidly earthed
- c) 240V Single Phase : Neutral solidly earthed
- d) 30V D,C, System : Unearthed

1.2 Inspection, Pre-Despatch Inspections and Testing by the Employer

i) Employer reserves the right for pre- dispatch inspection of Equipment at the manufacturer's place in India or abroad by the representatives of the Employer and Consultants along with Contractor or his/their representatives. The total cost of to & fro by Air or any other better conveyance charges, wherever the air routes are not available, boarding and lodging etc., shall be borne by the Contractor. In case the equipments are not found suitable for dispatch or whatsoever the defects may be and another inspection is required that visit also shall be arranged and borne by the contractor. The Employer shall not entertain any request on this account; even such inspection may be one or more, as may be required, before the dispatch of the Equipments. The discrepancies of such equipments as pointed out by the representatives of the Employer and the Consultants shall be rectified at the cost of the Contractor or the Manufacturer and the Employer shall not hold any liability on this account, what so ever may be.

ii) A mutually agreed quality assurance plan will be developed which provides for inspection and certification by the Employer at specified times during the manufacture and fabrication of such items. All costs for independent inspection or testing will be borne by the Contractor, and the Contractor shall be fully responsible to ensure that adequate provisions are made in his tendered rates to cover independent inspections and testing for the following equipments and machineries to be incorporated in the Permanent Works:

Sl. No	Name of the Equipment	Stages of inspection

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Sl. No	Name of the Equipment	Stages of inspection	
1.	Pumps	1	Review of material test certificate for pump casing, bowls, shaft, impeller bearings, columns pipe etc.
		2	Review of heat treatment certificate if any
		3	Dynamic balancing or rotating parts / impeller
		4	Examination of the shaft
		5	Hydro test of casing.
		6	Performance test at 49Hz and 50Hz frequency including vibration measurement covering following tests
		i)	Capacity in LPM / LPS
		ii)	Delivery Head in mtrs.
		iii)	Efficiency at the specified duty.
		iv)	Power absorbed by the pump at the specified duty.
		v)	N.P.S.H required.
		vi)	Maximum power required by the pump.
		vii)	Shut off Head of the pump.
		viii)	Discharge of the pump when only on pump is operated in the system.
		ix)	Delivery pressure when only on pump is operated in the system.
		x)	Power absorbed by the pump when only one pump is operated in the system.
		xi)	Efficiency of the pump when only one pump is operated in the system
		xii)	Visual and dimensional check.
		xiii)	Strip test.
		xiv)	Speed test at 49 Hz and 50 Hz frequency
2.	Motors	1.	Dynamic balancing of rotor and visual examination of rotor assembly.
		2.	Visual inspection and testing of stator assembly
		3.	Review of Test Certificate for conductor, Stator Coils, shaft Bearings etc.
		4.	Routine test no load x load test vibration measurement as per IS
		5.	Verification of type test report.
		6.	Visual and dimensional check.
3.	Switch Gear and Electrical Panels	1.	Visual and dimensional check.
		2.	Verification of bill of materials.
		3.	Functional Test.
		4.	H.V / I.R. Test.

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Sl. No	Name of the Equipment	Stages of inspection	
		5.	Verification of type test reports.
		6.	Voltage ratio, burden class, induced high voltage, applied high voltage test for potential transformers
		7.	Current ratio, burden, class of accuracy, test for current transformers.
		8.	Rate symmetrical breaking capacity, rated making capacity, rated short time current, auxiliary voltage for release coils, Impulse with Standard voltage test for Switch Gear panels.
		9.	Test results of Relay provided.
4.	Transformer	☐ Visual inspection, dimensional check and verification of bill of materials. ☐ Iron losses and Copper losses test at 90% of the rated voltage, 100% rated voltage and 110% of the rated voltage. ☐ Resistance voltage test at HV side and L.V side. ☐ Routine tests as per IS:2026. ☐ Verification of type results, temperature rise test, Impulse test, Insulating oil test etc.	
5.	Capacitor	All routine and type test as per IS:2834 such as sealing test, test for output / capacitance, Insulation resistance test between terminals. Containers and loss angle measurements, test for efficiency of discharge divide, test for dielectric loss angle, thermal stability test, self healing test, voltage test between terminals.	
6.	Cables	1. Visual Inspection and dimensional check. 2. Routine test as per IS: 1554. 3. Insulation test, resistance test, current rating test, star reactance test, star capacitance test, short circuit current test, voltage drop test.	
7.	Valves	• Visual and dimensional check. • Review of material test certificate for Valve body and internal parts. • Operational smoothness. • Hydrostatic test / leakage test as per applicable code.	
8.	Pipes & Specials	1. Visual and dimensional check. 2. Review of chemical and physical test certificates as per the relevant Indian Standard specifications. 3. Hydrostatic pressure test as per the relevant Indian Standard specifications. 4. Ultrasonic testing of welded joints for MS pipes 5. Checking the integrity of epoxy lining for MS pipes at joints after laying and jointing pipes.	
9.	Penstock Gate	1. Visual and dimensional check.	

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Sl. No	Name of the Equipment	Stages of inspection
		2. Review of chemical and physical test certificates as per the relevant Indian Standard specifications. 3. Hydrostatic pressure test as per the relevant Indian Standard specifications. 4. Checking the integrity of epoxy lining
10.	Screening Equipment	1. Visual and dimensional check up. 2. All the manufactures test certificates shall be submitted. If the Employer desires any test, contractor shall arrange to perform the same at no extra cost.
11	Aeration Equipment/Diffuser	1. Visual check up. 2. Oxygen transfer capacity.
12	Thickening/Dewatering Equipment	1. Visual and dimensional check up. 2. All the manufactures test certificates shall be submitted. If the Employer desires any test, contractor shall arrange to perform the same at no extra cost.
13.	Sedimentation Units	1. Visual and dimensional check up. 2. All the manufactures test certificates shall be submitted. If the Employer desires any test, contractor shall arrange to perform the same at no extra cost.
14.	EOT Crane	1. Visual and dimensional check. 2. Load test at 25% in excess of rated load. 3. Test for Deflection 4. Test for lifting speed.
15.	Actuators	1. Visual and dimensional check. 2. Speed for actuation 3. All the manufactures test certificates shall be submitted. If the Employer desires any test, contractor shall arrange to perform the same at no extra cost.
16.	Motors and Reduction Gears	1. Visual and dimensional check up. 2. Test for speed 3. All the manufactures test certificates shall be submitted. If the Employer desires any test, contractor shall arrange to perform the same at no extra cost.
17.	PLC, Automation, Field equipment	1. Visual and dimensional check-up. 2. Checking for suitability in terms of connecting, fitting, auxiliary voltage, necessary change over contracts. 3. Test certificate of all equipment and performance of equipment after connecting all controllers at local level and at remote level through controller.

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Sl. No	Name of the Equipment	Stages of inspection
		4. Display in terms of appropriate units and satisfactory calibration. Any error shall be removed. 5. Coding and addresses of all inputs and outputs. 6. Graphical representation alarm generation.

In addition to these the contractor shall carry out test of the other equipment in the presence of the third party agency with Employer engineers and shall submit test certificates for approval.

1.3 Guarantee

i) The Contractor shall guarantee all plant and machinery and their equipments supplied under the Contract, including erection and commissioning works, to be suitable for the application for which it is designed, and against defects due to manufacture or poor workmanship for a period of 12 months from the date of satisfactory completion of the stipulated trial run period. The Contractor shall be responsible to replace, free of cost, the whole equipment or parts thereof which may be found defective during this period, and to ensure the proper working of the equipment during the guarantee period. In case the Contractor fails to repair or replace any defective Equipment & machinery and equipment or part(s) thereof within 30 days from the date of intimation of any defects by the Engineer In-charge , the same will be done by the Employer/Engineer In-charge at the Contractor's cost.

ii) If it becomes necessary for the Contractor to replace or renew any defective portion of the plant or equipment under this Sub-Clause, the plant and equipment, so replaced and the work so renewed shall be guaranteed for a further period of 6 months from the date of replacement or renewal. Only genuine spare parts are to be used under the supervision and with approval of Engineer-in-Charge.

1.4 Certificates and Drawings for Electrical Installations

The Contractor shall furnish all the necessary data, drawings, layouts and test certificates, etc., as may be required by the power distribution agency and the Electrical Inspectorate Authorities in respect of all electrical installations, and shall

obtain any required approvals or clearances. Necessary assistance will be given by the Employer in this respect. It would be obligatory on the part of the Contractor to obtain such sanctions and approval of the electrical load from the concerned authorities

1.5 Suitability of Equipment for Indian Tropical Conditions

All plant and equipment supplied under the Contract shall be suitable for operation under the climatic and operating conditions prevailing at the Site. All parts, surfaces and sealants which are subject to corrosion shall be made of such materials, and shall be provided with such protective finishes, as are appropriate to protect the installed equipment from deterioration or injury due to the climatic conditions or operating environment. All electrical and auxiliary equipment shall be specially treated for Indian tropical conditions especially in city of Kota.

1.6 Display Panels

The Contractor shall provide such charts and drawings as are appropriate to clearly illustrate the process, operation and maintenance requirements of the plant and facilities provided under the Contract. Such charts and drawings shall be mounted on a panel, protected with a glass cover, and affixed on to the wall(s) of the plant/pump house/control room, as the case may be, and shall include, as appropriate, the following:

- General arrangement drawings.
- Wiring diagrams and detailed drawings of all electrical and mechanical installations.
- Assembly drawings for electrical and mechanical equipment.
- Charts indicating operations and maintenance details and schedules for electrical and mechanical equipment.
- Lists of commonly used spare parts and tools

1.7 Installation of Plants & Machineries

In case of all Electrical & Mechanical Equipment, plant & Machinery and fittings etc., the tendered rate shall include the costs of supplying, installation/erection,

fixing in position, testing and commissioning etc. at the site of work. No extra charges shall be payable on this account by the Employer. 6 sets of completion drawings, complete set of equipment brochures, dimensional details, approved drawings, installation manuals, pre commissioning tests, commissioning tests required to be carried out, shall be kept & made available at site for inspection of the Employer's officers. These sets will be given to Engineer-in-charge before commencement of supply/erection of equipment.

SPECIAL TECHNICAL SPECIFICATION FOR ELECTRO - MECHANICAL WORK (SEWAGE TREATMENT PLANT)

1.8 General Requirements

1.8.1 Material

All materials incorporated in the Work shall be the most suitable for the service conditions and duty concerned. They shall be new and of reputed make / approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause. All materials shall conform to the material standards as per BIS or any equivalent standard.

1.8.2 Workmanship

Workmanship and general finish shall be of first class quality and in accordance with best workshop practice. All welds shall be as per IS, BS, ASME standards. All tolerances and clearances shall be as per good and sound engineering practices. Should the Employer's representative not consider any material acceptable, it shall be replaced.

1.8.3 Design Features

As far as practicable, all designs shall be as per latest concept and practices. The equipment shall be new, of robust design for a long reliable operating life. These

shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the site and with a minimum of maintenance. Particular attention shall be given to extra temperature and the rating of electrical and mechanical equipment, cooling systems and the choice of lubricants shall be for the temperatures as specified.

Paints used shall be the manufacturers' standard and shall be suitable for duty as described. The equipment shall be designed to provide easy access to and replacement of component parts which are subject to wear without the need to replace whole units. All parts in contact with water shall have a life from new to replacement for 5 years minimum and new to repair of not less than five years.

Design features shall include the protection of equipment against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Equipment shall operate without undue vibration. Noise reduction measures shall be adopted such that levels of 75 dB (A) at 3 meters are not exceeded. Parts shall be designed to withstand the maximum stresses under the most severe conditions of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause which may have a detrimental effect upon the performance or life of the Plant.

All rotating elements shall be dynamically and statically balanced.

All equipment shall have name plates specifying the makes, model, rating and other pertinent information.

1.8.4 Lubrication

The equipment shall be lubricated by long life lubricants such that working life is not less than 3000 operation hours or as recommended by equipment manufacturer.

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Employer's representative for approval.

Lubricants shall be oil and grease. The Contractor shall indicate indigenously available equivalent lubricants, with complete specification.

Where the lubricant is grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Preferably, life lubricated grease packed bearings shall be used.

Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labelled.

1.8.5 Name Plates

Each equipment of the Plant shall have permanently attached to it a nameplate and rating plate in a conspicuous position, Upon these shall be engraved or stamped, the manufacturers name, type and serial number of the equipment, details of the loading and duty at which the equipment has been designed to operate, and such diagrams as may be required by the Employer's representative. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their functions and proper manner of use.

1.8.6 Painting At Manufacturer's Works:

The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant/ Equipment 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 testing, 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.

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts for wet duty are to be provided with an adequate number of coats of coal tar epoxy polyamine coating to

a dry film thickness of 175 microns excluding primer coating.

At Site:

Immediately on arrival at the site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works. Any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

After erection, such equipment/ items which are not finish painted shall be done so. Items that have been finish painted at the manufacturer's works shall be touched up for any damaged paint work. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.

The dry paint film thickness shall be measured by Elcometer or other instruments approved by the Employer's representative. In order to obtain the dry film thickness specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm². Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

Acceptable Makes: - Berger/ Shalimar/Asian/Woodlas/Neroalc

1.8.7 Galvanising

Wherever galvanizing has been specified the hot dip process shall be used And electro-galvanized parts, equipment shall not be permitted. 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 : 460 gms/sq. m
- b) Fasteners : 300 gms/ sq. m

Galvanising shall be carried out, after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

1.8.8 Supports for Pipe Work & Valves

All necessary supports, saddles, slings, fixing bolts & foundation bolts shall be provided to support the pipe work. Valve and other equipment mounted in the pipe work shall be supported independently of the pipes to which they connect.

All valves to be installed in straight lines shall be installed between the flanges with a dismantling joint or SS expansion bellow at one side of the valve. The dismantling joint must allow a minimum clearance of 20 mm. The pressure rating of the dismantling joint / expansion below shall be same as that of the valve.

1.8.9.1 Mechanical & Manual Coarse Screens

1. Purpose & Scope:

a. Mechanized screens (multi rake type) should be suitable for installation in Sewage pumping stations for removal of floating wastes coming along with sewage. These screens should be capable to screen out most of the medium and large floating material such as plastic bags, floating debris, weeds, paper wastes, clothes and rags etc. which are generally clogging the impellers of the pumps installed downstream of the screens.

b. The operation of the screen shall be automatic. An ultrasonic type differential level controller shall be provided to sense the head loss through the bar and give the signal to the traveling raking mechanism to start its operation. The sensor will signal the raking mechanism to operate continuously till the head loss is reduced to a preset level.

c. A complete electrical control system shall be supplied with each screen and shall be mounted independently near to the screen installation. The system shall provide for total automatic operation of the screen with the feedback from the

level controller.

2. General Material And Equipment Requirements:

a. Fabrication and design features:

- (i) Use power grinder to dull and produce smooth edges.
- (ii) Use bolted field connections. Field welding will not be allowed.
- (iii) Design all components for continuous 24 hours per day service.

b. The screen shall be so constructed so as to mechanically remove the waste from the bottom most portion of the bar portion using a traveling type raking mechanism without shutting the water flow through the screen. The raking mechanism shall then travel up to the top of operating platform and automatically discharge the waste through a discharge chute.

c. The screen shall have protection against overload conditions, which might damage the equipment.

d. All screens shall be constructed and shipped as an integrated product comprising of frame structure and guides, rake and rake arm mechanism, dead plates, cog wheels, sprockets and chains, discharge chute, drive unit and cover apron.

e. The screen shall be supplied factory assembled and duly tested at manufacturer's works before dispatch. This integrated and factory assembled screen shall involve minimum dismantling and assembly at site for erection.

f. Upon receipt at site these shall be installed resting on the channel floor and mechanically or chemically anchored to the parallel sidewalls of the channel (without making grooves in concrete or breaking open the concrete side walls and thereby weakening the civil structure) in a way that there are minimum chances of misalignment.

g. All parts shall be designed to withstand the stresses that will be imposed upon them during handling, shipping, erection and operation.

h. All stainless steel fabricated materials will be pickled and passivated before dispatch to remove ferrous contamination, if any.

3. Specifications :

- **Material of construction:**

All parts of screen including fixed bars, raking mechanism, screen frame and guide rails, dead plate and discharge chute shall be constructed from stainless steel material SS304 for long life in aggressive sewage environment. Suitable measures should be taken to ensure long life of parts like bearing, chains, sprocket and cogwheels etc, which are not made from stainless steel material.

- **Drawings & Documents:**

Drawings for the following shall be submitted for approval before taking up manufacturing of Screens:

General Arrangement drawing of screens.

Bill of Materials (BoM) & Wiring diagram of control panels.

Quality Assurance Plan.

All drawings shall be submitted in 3 copies of which one will be returned duly commented /approved.

Approval of manufacturer's drawings shall not relieve the manufacturer of his responsibility for supplying equipment confirming to the Technical Specification laid herein for any mistakes, errors or omissions in his drawings.

- **Screen Construction:**

- The bars shall be designed to have a tear drop profile so that they are wider on the upstream side and narrower on the downstream side. This is required to ensure that choking of bars due to stones and other hard material does not take place. The tear drop profile shall be 12 mm wide in the front and 10mm wide at the back and the depth of bars should be at least 60 mm.

- The bar rack shall be firmly anchored to the channel floor and supported by a dead plate at the top.

- The face of bars towards the incoming water should be half round (dia 12 mm) to ensure minimum resistance to the flow and avoid turbulence and also to offer guide and support to the rake (single/ multi rake) during its travel.
- The rake shall be made of Ultra High Molecular Weight Poly Ethylene (UHMWPE) so as to avoid the Galling between rake and bars. Further to this the rake should be provided with rounded off cavity to match the bars with a view to avoid sharp corner contact between the rake and bars thereby minimizing wear and tear.
- The rake arm shall ride on a cogwheel / roller in a single guide channel (min. thickness 5 mm in stainless steel) on each side of the rake and will be lifted away from the dead plate on the downward travel direction. Upon reaching the bottom of its travel the rake would be rotated/ swung into the bar screen to remove the collected debris.
- To effectively remove the debris from the bottom most part of the bar screen, the rake should engage with the bars from the start of its inwards rotating motion. To achieve this, the fixed bars should be curved at the bottom and taken forward so as to enable the rake to engage from the start of its inwards rotating motion.
- The rake arrangement shall be spring loaded to ensure that the rake is always pushed on to the dead plate.
- The dead plate shall be minimum 3 mm thick in stainless steel shall be suitably braced to ensure rigidity and prevent caving / bending due to increased water flow in monsoon.
- The sprocket for screen chains shall have chilled tooth bearing surfaces and the chain and sprocket shall be of the same material.
- The cogwheel and chains should be so located that these generally remain out of the flow of water during normal plant operation. An exception to this would be allowed only in case when water depth is greater than 2 m.
- The screen should have integrated scraper for discharging the screenings to discharge

chute. The scraper / wiper shall be cushioned during travel to the rest position by a shock absorber.

- The rake mechanism should be operated by an Electro brake motor and be suitable for automatic operation controlled by a level sensor and electric control cabinet. Torque switch should be provided to protect the screen from damages resulting from excessive torque.

- The screen shall be provided with non-corrosive apron and enclosure at the top above the

platform.

- After fabrication and assembly the stainless steel parts and all welded joints are to be further cleaned by acid pickling and after that they should be passivated to remove any ferrous contamination that might have taken place during manufacturing / handling / movement of raw and fabricated material.

- **Level controller**

The level controller shall be of ultrasonic differential type / level switch.

- **Electrical motor**

The motor shall be of TEFC type with IP 55 protection and suitable for operation on $415V \pm$

10% and frequency of $50 \text{ Hz} \pm 5\%$.

- **Control Panel**

The control panel shall have IP 65 protection, painted with epoxy paint and shall be comprising of

- Mushroom head emergency stop.
- Overload relays for motor protection.
- Circuitry to operate the screen with ultrasonic level sensor.
- Selector switch to operate the screen in Auto, off and JOG mode.
- Provision to run the screen on timer in case of failure of level sensor.

- **Shop Testing**

The screen should be completely manufactured and offered for inspection at the plant of the manufacture confirming the above mentioned eligibility criteria. A screen assembled by a vendor and offered for inspection at the plant of a vendor / sub contractor shall not be accepted. The screen shall be subjected to following tests at manufacturer's premises by third party inspection and / or Municipal Corporation representative(s):

- **Dimensional Check:** The overall dimension of the screen shall be conforming to the approved drawings.

- **Operational Test:** The complete screen including its carriage, rake, drive system and brake motor shall be mechanically operated and tested to verify interference free movement and satisfactory operation.

5.0 Miscellaneous:

Any type of work, either supply and or erection of material / equipment which have not been specifically mentioned in this specification, but are necessary to complete the works for trouble free and efficient operation and guaranteed performance of the entire plant system and equipment offered shall be deemed as included with in the scope of this specification and shall be provided by tenderer with out any extra price to purchaser.

The installation and commissioning of screens has to be done in the presence of manufacturer's representative(s) so as to avoid any possibility of misalignment and faulty installation. Minimum two (2) working days of training has to be imparted to the concerned Municipal Corporation people by the manufacturer's representative(s). Packing of screens and allied accessories shall be transit worthy to avoid any possibility of damage during the transportation to the site(s).

Manual Bar screen

The manual bar screen will be of opening not more than 20 mm for coarse screen and 10 mm for Fine screen and inclination about 55⁰ with respect to horizontal.

Specifications for Manually raked screen shall be as under.

The trash screen shall be rectangular in shape. The screen shall be fabricated out of stainless steel SS 304 of not less than 10mm thick and 50 mm wide in section. The screen shall be rigidly fixed to the frame and provided with 2 sets of cleaning rakes.

1.8.9.1.1 Mechanical fine Screens

1. General :

- Mechanically operated step Screen completely made of Stainless Steel having 6 mm clear spacing between the bars shall be provided in inlet screen channel for screening out floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other floating materials from the raw sewage coming from the pumping station / gravity mains.
- The screen shall include discharge chute as required to discharge the screenings on the bin without employing any external mechanism / rake mechanism.
- The screen shall be factory assembled & movement tested at plant before dispatch to site & shall only be installed at the site in factory assembled condition thereby avoiding chances of misalignments.

2. Scope :

Design, Supply, Installation, Testing & Commissioning of screening equipment consisting of following:

- (a) Mechanized step screen having 6mm spacing between bars and suitable for installation at an inclination of 40 degrees in channel.
- (b) Level sensing instrument connected to control panel for automatic operation of screen mechanism and allied accessories.
- (c) Local control panel installed near screen.
- (d) to discharge the screened material of the screen to the waste bin.

3. Specification

- **Material of construction:**

The fixed as well as movable bars, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel for long life in the aggressive sewage environment. No component of the screen assembly shall be made of carbon steel or any other material, which can get corroded in sewage environment.

- **Screen Construction**

- The step screen shall be a complete unit comprising of main frame with an integral mechanism containing movable bars located in between fixed bars without engagement of external mechanism / rake mechanism for pulling out the screened material ensuring minimum movement of the mechanism.

- The mechanism comprising of movable bars located between fixed bars shall gradually move the screened material upward in the form of a mat and deliver on the up to the discharge chute.

- The fixed as well as movable bars shall contain a series of steps to prevent the screenings from falling back into the main flow.

- The mechanism shall be mechanically operated by Electro-motor or hydraulic system and shall be suitable for automatic operation controlled by a level sensor.

- The screen shall operate automatically when the upstream water level of the screen increases beyond a pre-set limit and it shall stop when the upstream level decreases to a preset low level due to upward travel of screened material.

- The fine bar screen shall be capable of being tilted out of the sewage flow up to horizontal position for the purpose of cleaning & maintenance.

- The base of the screen shall be fitted with a specially profiled stainless steel plate to direct any grit that may be present towards the screen and taken out along with other screened material thus reducing the possibility of building up of grit in front of the screen.

- **Level Controller**

The level controller shall be differential type Ultrasonic level transmitter / level switch.

- **Electrical Motor**

The motor shall be TEFC type with IP 55 protection and shall be suitable for operation on $415V \pm 10\%$ and frequency of $50Hz \pm 5\%$.

- **Control Panel**

The Control Panel shall have IP 55 protection, painted with Epoxy paint and shall be comprising of

- Mushroom Head Emergency stop
- Overload relays for motor protection
- MCB's, HRC Fuses and Glass Fuses
- Circuitry to operate the screen with level sensors.
- Selector Switch to operate the screen on JOG mode

1. Shop Testing

The screen should be completely manufactured and offered for inspection at the plant of the manufacture confirming the above mentioned eligibility criteria. A screen assembled by a vendor and offered for inspection at the plant of a vendor / sub contractor shall not be accepted. The screen shall be subjected to following tests at manufacturer's premises by third party inspection and / or NDA representative(s):

- **Dimensional Check:** The overall dimension of the screen shall be conforming to the approved drawings.
- **Operational Test:** The complete screen including its carriage, rake, drive system and brake motor shall be mechanically operated and tested to verify interference free movement and satisfactory operation.

1.8.10 Mechanical grit separator

The grit separator shall be square in size and twin unit construction. A Central drive mechanism of worm reduction type driven through helical gear and motor or by geared motor shall be mounted on the RCC platform spanning the tank. All exposed steel parts shall be sand blasted and painted with epoxy. All wetted parts shall be in stain steel 304. The drive shall be provided with electro-mechanical device, torque indicating arrangement and mechanical trip contacts with electrical overload relays. Flow regulating vanes shall be provided at the inlet side of the collection chamber and shall be of FRP. The vanes shall be adjusted as per the flow requirement. The weirs at the outlet of grit chamber shall be SS 304 with minimum 3-mm thickness or FRP with minimum thickness of 6 mm. The spacing of anchor bolts of SS 304 for the fixing of the weir shall not be more than 450 mm.

The classifier mechanism shall comprise of a screw driven by a suitable motor. The material of construction of the mechanism shall be SS 304 of suitable dia. The length of screw shall be such that the grit can be elevated up to the discharge end. SS puddle pipe shall be provided in the concrete trough at the discharge point of wet grit. An organic return pump with wetted parts in SS304 shall be provided.

1.8.11 Air blowers for Oxygenation

The blowers shall be provided for providing adequate oxygen into the reactor tank for aeration. The air requirements shall be calculated for summer and winter as well as for mixing power the higher duty shall be installed. The summer sewage temperature shall be taken as 35 degrees C and that in winter at 10 degrees C.

The blowers shall be capable of developing the required total pressure at the rated capacity for continuous operation. The blowers shall be Tri lobe or Twin lobe type. The blowers shall be provided with suction air filter, reactive silencer, dead weight pressure relief valve and pressure gauge and the air delivered shall be clean, dry and oil free. The blower noise level and velocity of vibration shall be within 85 dB (A) at a distance of 2 m respectively. Blower shall be provided with soundproof canopy as per standards. The blower must be V-belt driven by squirrel cage induction motor.

The speed of the blowers shall be below 1,500 rpm. The power rating of motor shall be at least 10% above the maximum power requirement by the blower. The kW of single blower shall not exceed 250 kW. The blowers shall be mounted at a level necessary to avoid back flow or siphoning of sewage into the blower.

Material of construction:

Casing	: C I conforming to IS: 210 Gr FG 260
Rotor	: Alloy steel
Shaft	: Carbon steel C40/EN 24/19
Timing gear	: Cast alloy steel
Pulley and gear side plates and cover	: CI conforming to IS 210 Gr FG 260

Sr. No.	Tests	Specs
1	Hydrostatic tests	Twice the maximum working pressure
2	Performance test	As per BS : 1571
3	Strip test	Clearances with tolerance limit
4	Mechanical balancing	ISO 1940 Gr. 6.3 or better
5	Visual Inspection	Before painting

.8.12 Diffused Aeration System

This comprises piping to diffusers and the diffusers.

- Type of diffuser system**

A fine bubble diffused aeration system shall be applied to aeration tank for oxygenation. The number of diffuser elements can be varied by the bidder depending on the manufacturer selected, subject to the condition that sufficient design calculations are attached along with it and the manufacturer is a standard one having supplied the diffusers to various waste water treatment plants of similar nature.

- Diffuser Elements**

The diffuser elements shall be of PU tubular membrane type and resistant to such ingredients as hydrocarbons, oil and grease. This shall afford a high oxygen transfer rate coupled with a minimal pressure drop besides permitting simple erection onto the horizontal air manifold. They shall have self-cleaning properties while in action. The diffuser unit shall be of corrosion resistant material. The membrane diffusers shall permit connection to the air manifolds of circular or square cross section and the entire lot of diffusers shall be capable of discharging designed flow of air at an average flow (maximum of summer and winter requirement) when installed in the said SBR tanks.

The diffuser grid shall be of fixed type. The headers onto which the diffusers are fixed shall be of standard Imported PVC/UPVC pipe sections of suitable inner bore and shape with custom fixtures of the diffuser elements as directed by the membrane manufacturers. Alternative pipe materials shall be acceptable provided the same are a mandatory part of the diffuser supplier and have been in the supplier's line of supply as original equipment. The headers shall also be procured from the equipment manufacturers who are the suppliers of the membrane diffusers. These headers shall have enough counterweight or alternative arrangement to surmount any buoyancy lift from the floor during air charging.

- **Air Supply Piping**

The air piping from the blower to the basin header (above water) shall be of MS epoxy painted material and pressure rated for the sewage depth plus frictional losses etc. Each air header shall travel downward from the air piping by aligning itself onto the sidewall of the aeration tank and thereafter travel horizontally onto the tank floor. These shall be fixed securely to the concrete surfaces in the horizontal plane and vertical plane so that they are not clamped horizontally onto vertical sides of the walls. The clamping shall be so designed as to permit "in-situ" screw driven fittings. Breaking open concrete surfaces shall not be permitted.

1.8.13 Specifications for Epoxy Painting

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for

external and internal painting. No primer shall be applied without prior approval from the Employer's Representative. The max of zinc rich epoxy primer shall be prepared at work site not earlier than 15 minutes before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer of DFT 75 micron shall be applied along with two coats of epoxy paint DFT 40 micron and DFT 30 micron respectively. No thinner shall be added to ready mix paint without previous approval of the Employers' representative and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at-least 48hrs.

After application of zinc rich epoxy primer the surface should be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

Mixed paint should be used within 3 to 4 hrs. of mixing and fresh mixing shall be done for every new application. Every successive coat of paint shall be given only after 48 hrs. of previous coat. Before applying the next coat the surface should be properly cleaned by duster.

1.8.14 Specifications for Decanting Drive

The decanting device shall be rotating moving arm devices of Stainless Steel with top mounted gear box, drive, scum guard, down comers, collection pipe, bearings. The maximum design travel rate shall be 60 mm/min. with proven hydraulic discharge capacity of the decanter proportional to the selected basin area.

- There should be Maximum 1 decanter per basin.
- The hydraulic design based on design flow rates as given above shall not exceed flow speeds of 1.3 m/s.
- Flexible rubber hose kind of decanter sealing is not acceptable.
- One or more decanters shall be provided in each basin which functions under a controlled lowering rate to withdraw treated water out of SBR / Cyclic Activated Sludge Process Basins.
- The decanting mechanism shall be designed for a variable speed mode of operation. Decanter shall be capable to travel at varying speeds. The rate of travel

of the decanter shall be adjustable during its travel in air and into the liquid surface, at which point the rate of travel of the decanter shall be automatically adjusted to a calculated rate of operation. The maximum design travel rate shall be restricted to 60 mm/min. Rope driven or Fixed subsurface arrangements will not be acceptable.

- The rate of operation shall be calculated for each cycle and shall be determined by the volume of treated effluent to be discharged per cycle. The calculation of decanter travel shall ensure that the volume of treated effluent shall be discharged throughout the designated decant phase of the process cycle. The travel of the decanter shall be limited and controlled by limit switches which shall communicate with the PLC. Upon reaching the designated BWL, the decanter shall return to its parked position.

- During non-decanting cycles, the decanter collection weir shall be parked above the top water level of the basin during aeration and settling phases, thereby eliminating any possibility of solids carryover during these phases. Therefore weirs or entry ports of the Decanters shall not be submerged below the top water level of the basin during non-decant phase. Each decanter shall be fitted with a scum retention mechanism to prevent surface scums and floatables from exiting with the treated effluent.

- In addition, at park position, the decanter shall also provide fail safe overflow protection in the event of a power failure by allowing clear supernatant to flow via gravity, under the scum guard, over the weir, and into the decanters and out of the basins.

- If more than one decanter is provided per basin, operation of all decanters shall be synchronized precisely using synchronization panel to achieve even distribution of flow through each decanter.

- Weir loading for each decanter shall not exceed 140 m³/hr/m of the inlet weir. During Decanting Phase, decanter weir shall always be visible from the basin walkway to provide the operator with a visual check of the effluent quality. Maximum velocity down comer shall not exceed 1.0m/sec. at the designed decant

flow.

- All components of the decanter except seals and bearings shall be constructed of stainless steel 304. The decanter seals and bearings shall be constructed of maintenance free, synthetic materials for longest possible service life. All seals and bearings shall be shipped factory assembled, simplifying installation. All fasteners shall be constructed of 304 stainless. Site fabrication of decanters shall not be allowed.
- Drive mechanism or actuator shall be equipped with variable frequency drive connected to PLC to facilitate its operation at varying flow rates to ensure controlled and seamless operation at varying flow rates. Complete Drive Mechanism shall be mounted on the walkway to provide easy access for maintenance and service purposes.
- All critical decanter components that may require routine inspection or maintenance shall be easily accessible from an access platform at basin coping level without taking a basin out of service or draining or partially draining the basin. It shall be possible to carry out decanter maintenance activities without interrupting normal operation of the basin while the decanter is at its parked position during non-decant phases of the process cycle.
- The SBR blowers, Automatic Air supply Valves, RAS Pumps/Mixers, switching mechanism shall be interlocked with the decanter controls so that aeration/mixing is prevented in a basin which is settling or decanting.

1.8.15 Submersible Pumps for Return and Excess sludge

Raw sewage pumps shall pump sewage from wet well at sewage pumping station to inlet chamber of STP. Return sludge pumps shall pump the return sludge from the sump to the aeration tank. Pumps shall be submersible type of non -clog design. They shall be suitable for pumping soft solids normally present in raw sewage. Raw sewage pumps with maximum 960 rpm shall be provided. In addition to this, the pumps shall be fitted with a special tearing system on the suction side for tearing soft solid material. The impeller shall be of a non-clog design with smooth passage

and desired solid handling capability. Maintenance-free anti-friction bearing, deep grooved permanently greased filled ball bearings shall be provided to take care of all the axial and radial forces at any point of operation. The pump installation design shall be such as to facilitate automatic installation and removal of the pumps without having to enter into the sewage pit. The motor shall be squirrel cage type, suitable for three phase supply continuous duty with class 'F' insulation. Motor shall have integral cable parts and the cable entries shall be sealed. The cables must be leak tight with respect to liquids and firmly attached to the terminal block. The motor shall be designed for non-overloading characteristics. There shall be thermal protection against overheating of the motor winding. The pump design shall ensure that seal does not come directly in contact with the liquid being pumped as well as cooling / lubrication by oil is provided. The moisture sensor of the tripping unit shall be located inside the oil chamber.

The pump unit shall be supplied along with the special duck foot bend, flanged elbow, lifting chain with shackles, enough guide wire / pipe, sufficient tough rubber sheeted water proof cable, as well as stainless steel foundation bolts and nuts. Alternatively pump unit can be with SS wire rope guiding system and pedestal cart integrated with the discharge head.

- **Reverse Rotation**

The pump shall be designed to operate safely in the reverse direction of rotation, due to wastewater returning through the pump.

- **Pump Construction**

Refer Section - 2.0 Scope of Work of the tender.

- **Pump Bearings**

Pump bearings shall be of the antifriction type. The bearings shall be able to take normal axial thrust loads due to unbalanced hydraulic loads on the impellers plus the weight of all rotating parts of the pumps. Pump bearings shall be designed with a minimum life of 40,000 hours. The bearings shall be grease lubricated for life and shall be maintenance free

- **Mechanical Seals:**

A double mechanical seal of approved type shall be provided to prevent pumped liquid entering into the motor winding. The seals shall be running in oil bath. The oil bath shall have moisture sensors to sense water leakage. The sensors shall be used for tripping the pump and also for alarm.

- **Pump Balance:**

All rotating parts shall be accurately machined and shall be in rotational balance. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case the amplitude of vibration as measured at any point on the pumping unit shall not exceed the limits set forth in the latest edition of Indian Standards. At the operating speed, the ratio of relative speed to the critical speed of the unit or its components shall be less than 0.8 or more than 1.3.

- **Lifting chain**

Each pump shall be provided with galvanized steel lifting chain of suitable capacity. One end of the chain shall be attached to the pump and the other end fixed near the upper bracket for guide rail / wire rope assembly, by means of GI D shackle. The chain shall have GI rings fixed at an interval of about 1 meter for engaging the hook of the chain pulley block.

- **Submersible Cable**

Each pump shall be provided with submersible cables of equal length for power and control so that the pump positions can be interchanged with each other. The cable shall be terminated in a common weatherproof junction box.

- **Moisture Sensor**

The moisture sensor shall be provided in the oil chamber to detect the failure of the mechanical seal.

- **Motor**

The motor shall be integral part of the pump. The enclosure for motor shall be IP-68. Each phase of the motors shall be provided with thermostat. The motor winding shall be suitable for star delta/soft starter. The motor shall be designed for minimum 10 starts/stops per hour, irrespective of whether it is DOL start or otherwise. For other requirements refer subsection VI. The motor shall operate satisfactorily at all operating levels in wet well.

- **Protective Coating:**

The pumps shall be epoxy painted.

1.8.16 Other Sludge Pumps

These pumps shall be of screw type used for pumping sludge to centrifuge. The pumps shall be designed to operate satisfactorily without detrimental surges, vibration, noise, or dynamic imbalance. Over the required head range, the head-capacity curve of the pump shall have a continuously rising head characteristic with decreasing capacity over the whole range of total head. The pump shall have the maximum efficiency at the specified duty point. The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to sewage returning thro the pump at times when power supply of the motor is interrupted.

All rotating parts shall be statically and dynamically balanced as per ISO standards.

A stationary coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Guards shall be designed for easy installation and removal. They shall be complete with necessary support accessories and fastener.

The pumping unit shall be provided with a common base plate. The base plate shall be of sufficient size and rigidity to maintain the pump and motor in proper alignment and position.

The pump design shall be as per IS 6595 and pump performance shall be as per IS 9137. The power rating of the pump motor shall be the larger of following

- (i) 115 % of power required by the pump at the duty point
- (ii) 110 % of maximum power required by the pump from zero discharge to the runoff point total head.

- **Material of Construction & Specifications**

Type Screw

MOC Alloy Steel

Base plate CI / MS Epoxy painted

Fastener SS AISI 304

Pump speed 960 rpm (maximum)

Ball passing size	25 mm minimum

Applicable code

Design IS 6595

Performance IS 9137

- **Testing**

Material test certificate Casing, Impeller, Shaft

Hydrostatic test 1.5 times shutoff head or twice the rated discharge head whichever is greater

Performance test IS 5120 and IS 9137 at full speed

Mechanical balancing As per ISO 1940, Gr. 6.3 or better

Visual inspection Pump shall be offered for visual inspection before shipment. The pump components shall not be painted before inspection

Field Tests	Field performance tests required for satisfactory operation

1.8.17 Dosing Tank Agitators

The equipment shall include drive motor, coupling, turbine impeller assembly, intermediate bearings, basket, walkway with handrails and such other fittings, devices or appurtenances necessary for a complete operating installation.

- **Mounting Arrangement**

The civil tank for the sludge storage will be provided with a minimum freeboard of 300 mm. The agitator drive unit shall be mounted on RCC platform spanning the tank. These shall be mounted above the freeboard elevation over a RCC bridge walkway with necessary cut out for agitator shaft. The walkway will be provided with hand railing in SS 304 and steel ladder with handrails. A portal shall be provided permanently in the platform required for the maintenance work of the agitator components.

- **Drive Motor**

The drive motor shall not exceed an rpm of 1500 and shall be directly coupled with the gear reducer. It shall be wired for 415 volts, 50 cycles, and three-phase service. It shall be totally enclosed, fan cooled, and rated for severe chemical duty with a minimum service factor of 1: 1.15.

- **Rotary Speed**

The rotary speed of the impeller shall not exceed 100 rpm so that the solids are not sheared.

- **Direct Coupling & Torque**

The drive motor output shaft and the impeller rotary shaft shall be connected by a direct coupling using such couplings as “Lovejoy” type to avoid cumbersome erections and de-erections. The coupling shall be able to withstand continuous duty with occasional upward thrusts. The drive assembly for each agitator shall consist of a suitable drive motor, directly coupled to a helical gearbox. The gear reducer shall be of heavy duty, high efficiency type with a rugged housing and shall have a minimum service factor of 2.0 and suitable for 24 hours continuous service. The gear reducer shall have oil bath lubrication and dry well construction on the vertical out put shaft to prevent leakage of lubricant. The

casing of the gear reducer shall be of CI and the gears shall be hardened and ground for precision.

- **Impeller Elements**

The circulating element of the each agitator will consist of a single, axial flow design, 4 inclined impeller having SS304 blades

- **Fasteners & Anchor bolts**

All fasteners and anchor bolts shall be of such metallurgy that shall be compatible with the duty conditions shall be used.

1.8.18 Dosing Pumps

The dosing solution from the preparation tanks shall be pumped by the use of dosing pumps. The pipe and the pipe fittings shall be HDPE and valves shall be Polypropylene.

These pumps shall be capable of pumping the up to 0.5 % Polyelectrolyte solution. Dosing pumps shall be of the diaphragm type hydraulically operated. These shall permit flow control at both sides of the chosen median duty point for the duty already stated herein. The construction shall be totally enclosed and corrosion proof. The liquid end shall be in SS 304.

1.8.19 Centrifuge

The centrifuge shall be solid bowl centrifuge of co-current/counter current design, as decided by the bidder. The centrifuge shall have sufficient clarifying length so that separation of solids is effective. The centrifuge and its accessories shall be mounted on a common base frame so that entire assembly can be installed on an elevated structure.

Suitable drive with V- belt arrangement and turbo-coupling shall be provided along with overload protection device. Centrifuge shall be with SS304 wetted parts.

Differential speed and bowl speed should be adjusted by changing the pulleys; differential speed may be adjustable by use of epicyclical-gear. The bowl shall be

protected with flexible connections so that vibrations are not transmitted to other equipment. The base frame shall be in epoxy painted steel construction and provided with anti-vibration pads. All steps necessary to prevent transmission of structure borne noise shall be taken. The drive motor shall be of 1450 rpm. The noise level shall be 85 dB (A) measured at 2 m distance under dry run. The vibration level shall be below 50 micron measured at pillow blocks under dry run condition. Adequate sound proof shall be carried out for the housing the centrifuges to ensure that the noise level at 5 m distance from the enclosure is less than 75 dB (A).

Centrifuge shall be capable of handling sludge consisting of minimum 0.8% solids by weight. The dewatered cake shall be based on minimum consistency of 20% by weight dry solids.

1.8.20 Disinfection System

Shall include:

1.8.20.1 Chlorination System

- **Chlorinators**

- (a) Vacuum type chlorinators shall be supplied with one duty and one stand by unit.
- (b) Chlorinators shall be free-standing, floor-mounted, and shall have a turn down ratio of 10:1 over the full range of works operation.
- (c) The dosing rate shall be manually set and each chlorinator shall be equipped with a 0 to 10mg/l scale and a manual dose setter over the complete range.
- (d) Mal-operation of the duty chlorination system shall be indicated in the chlorination room and the central MMI. The change to the standby system shall be carried out automatically in the event of duty chlorinator failure.

- **Dosing Pumps**

- a) Dosing pumps (1 working + 1 standby) shall be installed.

- b) The dosing pumps shall draw their supply from treated sewage line.
- c) The pumps shall be placed inside the chlorination room and shall be made from material resistant to corrosion by chlorine.

- **Injectors**

Two injectors shall be provided, each serving a duty /standby pair of chlorinators. The injectors shall be located in the chlorination room.

- **Chlorine**

Chlorine shall be supplied as liquid from nominal 1 tonne chlorine toner.

1.8.20.2 The Toner Room

- (a) Storage shall be provided for chlorine tonners, sufficient for at least 15 day's usage at normal rate of withdrawal.
- (b) The system shall be designed to prevent freezing of the liquid chlorine at the maximum rate of withdrawal.
- (c) Tonners on line, tonners on standby and full and empty tonners shall be stored separately in the tonner room. Three sets of tonner rollers shall be provided. Tonners not in use shall be stored on concrete cradles.
- (d) The container lifting beam shall be specifically designed for handling chlorine containers and equipped with necessary shackles and hooks.
- (e) Operation of crane system shall be from the floor level using independent push button pendant controls operating at a 230 volt 50Hz AC supply.
- (f) Two lifting beams shall be provided (a duty and a spare) and a one tonner weighed to be suspended from the crane hoist.
- (g) When the pressure in the duty chlorine tonner falls to less than 1.00 Kg/cm^2 , the automatic change over device shall operate to isolate the empty tonner and to bring the full standby tonner on line.
- (h) A chlorine leak absorption system shall be provided to contain and neutralize chlorine in the event of leak. The system shall comprise FRP Half Hoods, NaOH Storage Tank, NaOH Re-circulation Pump, Centrifugal Pumps and interconnecting

ducting/piping.

(i) Special consideration shall be given to any floor drainage system in the tonner building; adequate shall be provided to ensure that chlorine gas cannot escape. All leader tubes carrying cables or pipes out of the building shall be sealed at either end to prevent any chlorine gas leaking out.

1.8.20.3 Chlorination Room

(a) The chlorination room shall be constructed adjacent to the tonner room but with no interconnecting door or other form of access.

(b) Gas lines from the tonner room into the chlorination room shall run in ducts to be sealed after installation and prior to commissioning.

1.8.20.4 Chlorine Leak Detectors

Chlorine gas leak detectors shall be provided each, with a single detector cell. At least two sensors shall be located in the chlorine tonner storage room and at least one sensor in the chlorination room.

The chlorine leak detectors in the tonner room shall be mounted at each end of the tonner room.

The chlorine leak detectors shall initiate a local audible and visual alarm. Statutory warning notices relating to the storage and handling of chlorine shall be provided. The signs shall be pictorial and provided in Hindi and English.

1.8.20.5 Ventilation System

a) Each area where chlorine is stored or used as gas or liquid shall be provided with a forced ventilation system.

b) Air intakes shall be sized to allow uniform ventilation and positioned to prevent possible recirculation.

c) An air change rate of four per hour under normal condition and a minimum of twenty changes of air per hour under shall be used in the event that a chlorine leak is detected.

d) Exhaust fans shall be heavy duty industrial pattern manufactured from chlorine

resistant materials.

1.8.20.6 Safety Equipment

(a) Materials and equipment necessary to ensure the safety of personnel operating the chlorination plant and others shall be provided.

(b) The equipment shall include:

(i) two sets of approved self-contained breathing apparatus, each comprising an air set, carrying harness, face mask and valves and ancillary equipment . Each set shall be provided with three 1200 liter capacity, 140mm diameter, air tonners.

(ii) Two 'instant action' resuscitators;

(v) Four sets of safety clothing in various sizes, each comprising PVC overalls, Wellington boots with steel toe caps, goggles, gloves and safety helmets.

(c) Each set of safety equipment shall be mounted in a glass-fronted, non-locking PVC coated steel cabinet in approved locations on the outside of the building.

(d) Two emergency showers shall be provided and shall be installed outside on either side of the tonner room.

(e) Each shower shall be operated automatically by a quick acting hand or foot valve.

(f) Four eyebaths shall be supplied. Two eyebaths shall be adjacent to each of the showers.

(g) Water for showers, etc. shall be drawn from the service water supply.

(h) A telephone will be provided close by outside the building for emergencies.

1.8.21 Valves

1.8.21.1 General

Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS 6392. Valves shall be flanged type. For sluice / gate calves, back seat arrangement shall be provided. Valves buried or

installed in underground chambers, where access to a hand wheel would be impracticable, shall be operated by means of an extension spindle and / or keys. Valves shall be suitable for frequent operation as well as operation after long periods of idleness in either the open or closed position. 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. All valves parts shall be in general of the material of construction best suited for the proposed application. The inspection category is detailed in subsection VII.

1.8.21.2 Sluice Valves

The gate face rings shall be securely pegged over their full circumference. Valves of 450 mm and above shall be provided with a thrust bearing arrangement for ease of operation. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5mm. Alternatively, valve of diameter 450mm and above may be provided with a 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 gearing shall be such as to permit manual operation in a reasonable time and not to exceed a required rim pull of 80 N. All hand wheels shall be arranged to turn in a clockwise direction for opening and counter clockwise for closing. These directions shall be indicated on the hand wheels. All valves shall be rated for not less than PN 1.0.

All valve doors when fully closed will ensure door faces are riding on body seat ring by at least 50% of width of seat ring providing sufficient allowance for wear. Valves of diameter 450 mm and above shall be provided with a drain and air plug.

Material of Construction

Body, Bonnet, Wedge	CI conforming to IS 210 Gr FG 260 Spindle
Drain and Air Plug	IS 318 Gr LTBZ

Seat Ring, Wedge Ring	SS 304
Back seat Bush	Bronze IS: 318 Gr LTB 2
Gland Packing	Graphite Asbestos

Parameters

Type	Rising spindle
Nominal pressure	2 times working pressure in pipeline
Nature of operation	Horizontal / vertical
Applicable code	IS 14846
Test	Acceptance tests as per IS 14846

1.8.21.3 Knife Gate Valves

Knife gate valves shall be suitable for use at suction and delivery side of pumps in a sewage pumping station. The valve should be provided with gate made of stainless steel and the gate should have bevelled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off / closure in sewage environment. The valve should be bonnet-less and suitable for face to face flange connections in between pipelines. It should be suitable for uni-directional application.

The valve body should be of Cast Iron Gr. FG 260. The body shall be designed to withstand 6 bar pressure.

The valve shall be provided with replaceable type flexible sealing seals to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by an easily removable type seal retainer ring. The seal retainer ring should be designed in a manner so that the flow of the fluid should be away from the sealing perimeter and towards the centre of the valve.

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished & buffed.

The valve shall be provided with sufficient ply of stuffing seals in the in built stuffing box to seal the rear opening. The stuffing box should have internal tappers for pushing the seals on to the gate. The seals should be of non-asbestos PTFE to reduce the friction and offer higher life. Provision shall be made to enable tighten the stuffing seals by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of stuffing seals should be done in installed condition of the valve.

The spindle should be double start threaded and non-rising type for compact & safe operation. The gate movement area should be covered by protection shields. Gate opening indicating arrangement should be provided to find out the extent of gate opening /closing.

Flange drilling suitable to mount between flanges as per IS 1538 -1993.

- Body: Cast Iron FG 260 as per IS 210
- Knife gate: AISI:304 Gr. ASTM A240
- Retainer ring: SS:304 ASTM A351 Gr. CF:8
- Inlet Seal: EPDM
- Spindle: AISI:410 Gr. ASTM A276
- Spindle Nut: Cast Iron Gr. FG 200 as per IS 210
- Stuffing plate: Cast Steel ASTM A216 Gr. WCB
- Stuffing seal: Synthetic yarn with PTFE

1.8.21.4 Reflux Valves

Reflux valve shall possess high speed closing characteristics and be designed for minimum slam conditions while closing. External counterweights are not acceptable. Check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The pressure drop in the valve at design flow shall be limited to 0.4 mWC.

Material of construction

Body	CI conforming IS 210 Gr FG 220
Contractor	No. of correction
	Executive Engineer

Plate	SS AISI 316
Spring	SS AISI 316
Seal	SS AISI 304

Parameters

Nominal pressure	Twice the pressure in pipeline
Nature of operation	Automatic
Closure characteristic	Non slamming
Applicable code	API 594
Tests	Acceptance tests as per API 598

1.8.22 Pipe Work

The pipe works for the plant involves procuring, supply, laying and jointing of suitable size electrically welded steel, cast iron, ductile iron, UPVC, RCC and PSCC pipes along with matching specials etc. as required. All pipe work and fittings shall be a class rating in excess of the maximum pressure attained in service including any surge pressure. The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps or major items of equipment. All pipe work shall be adequately supported with purpose-made fittings, wherever necessary. Flange adapters and union shall be fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment. The Contractor shall be responsible for ensuring that the internal surfaces of all pipe work are thoroughly cleaned before and during erection and commissioning. Cleaning shall include removal of dirt, rust, scale and welding slag due to site welding. Before dispatch from manufacturers works, the ends of the pipe, branch pipes etc., shall be suitably removed until immediately prior to connections adjacent pipes, valves or pumps. All small-bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Employer's representative. All underground-buried mild steel piping unless found otherwise necessary, shall be protected by the application of hot coal

tar enamel and fibreglass wrapping. The coating shall consist of one coat` tar primer one coat, wrapping of fibre glass one more coat of enamel and the final wrap of enamel impregnated fibre glass. However, all water supply plumbing pipelines shall be of GI class B and either anchored externally with SS AISI fasteners or appropriately buried below the ground with a sand cushion of 20 cm all round. All sanitary piping shall be of UPVC class 4 suitably buried below the ground with a sand cushion of 20 cm all round. Changes in direction on the ground shall be achieved with inspection chambers of 45 cm x 45 cm and heavy-duty CI/Steel reinforced fibreglass chamber covers.

1.8.22.1 C I Pipes

The C I pipes and specials their laying and jointing and their dimensions shall conform to IS 1536, IS 1538 and IS 3114 with their latest revisions. The quality of cast iron shall meet grade 15 of IS 210 and be free from flaws, air bubbles, cracks, sand holes and other defects and shall be truly cylindrical and of uniform thickness. The methods for sampling of C.I. pipes and fittings shall conform to IS 11606. Pipe work outside the buildings shall use Tyton ring joints and inside, double flanged joints. All underground pipes shall be provided with granular bedding. Thrust blocks wherever required in the opinion of the Employer's representative shall be provided in accordance with relevant specifications of the BIS

- **Tests:**

Following tests shall be carried out on the C.I. pipes:

- (i) Mechanical Tests

as specified in I.S. 1536 during manufacture of the pipes.

- (ii) Hydrostatic tests at works

The pipes shall be tested hydrostatically at the pressure specified in Table 1 for spigot and socket pipe and as per Table 2.0 for flanged pipes of IS 1536. The pressure shall be applied internally and shall be steadily maintained for a period of minimum 10 seconds and the pipes shall be moderately struck with a 700 gm hammer. The pipes shall withstand the pressure test and shall not show any sign of leakage, sweating, cracks or fracturing or other defects.

(iii) Testing at site

The following site tests shall be carried out after a new pipe is laid, jointed and partially backfilled.

(a) Pressure test

The pressure test at a field test pressure specified in clause 7.2.1 of IS 3114 shall be carried out. Pipes and joints shall be absolutely water tight under the test. The procedure for testing shall be as per clause 7.2.1 of IS 3114.

(b) Leakage test

The leakage test shall be conducted as per clause 7.3 of IS 3114 and the leakage should be within the specified allowance as calculated using formula given in clause 7.3.2 of IS 3114.

(c) Water required for any type of testing shall be arranged by the Contractor, at his own cost.

(d) Markings:

The following markings on the pipe shall be cast, stamped or indelibly painted-

1. Manufacturer's name or identification mark
2. The nominal diameter
3. Class reference
4. Mass of pipe
5. The I.S. Code reference
6. The year of manufacture

The marking shall be done outside the socket or towards the end of barrels of the pipe. The coating on the pipes, both internally and externally shall be provided as per clause 15.0 of IS 1536.

1.8.22.2 Galvanized Iron pipe

The procurement, supplying, laying, jointing and testing at works and site of Galvanized Iron (G.I.) pipes and fittings shall be in accordance with IS 1239 (Part I

and II) and its latest revisions. The general requirements relating to the supply of mild steel tubes shall conform to IS 1387. The sulphur and phosphorus requirements in steel shall not exceed 0.05 percent each. The galvanizing of the pipes shall be as specified in IS 4736. The zinc coating shall be uniform adherent, reasonably smooth and free from imperfections. The pipes shall be galvanized before screwing. All screwed pipes and sockets shall have pipe threads conforming to the requirements of IS 554. Gauging in accordance with IS 8999 shall be considered as an adequate test for conformity of threads of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads. The specifications for G.I. pipes shall be generally in accordance with Clause 15.4 of standard specifications. The tolerances on the length of pipes shall follow clause 11.0 of IS 1239 (Part I). The fittings for G.I. pipes shall be of mild steel tubular or wrought steel fittings conforming to I.S. 1239 (Part II). The laying of G.I. pipes and fittings shall follow the relevant I S code of practice. These pipes shall be used for drinking water supply for the office and laboratory buildings. The pipes shall be painted with two coats of anticorrosive bitumen paint.

- **Testing of G.I. pipes**

Hydrostatic test shall be carried out at works at a pressure of 5 M Pa, maintained for at least 3 sec and shall not show any leakage in the pipe. The tensile strength of length or strip cut from selected tubes, when tested in accordance with IS 1894 shall be at least 320 N / mm². The elongation percentage shall be as per clause 14.1.1 of IS 1239 (Part I). The bend test shall also be carried out as per clause 14.2 of IS 1239. The G.I. pipes and fittings shall be tested at site, after they are laid and jointed as per clause 15.4.11 of standard specifications.

1.8.22.3 LDPE Pipes: (Low Density Poly Ethylene Pipe)

The International standard specifies the required properties of pipes made from poly ethylene (PE) confirming to ISO 4427:1996.

- **Dimensions**

The dimensions of pipes shall be measured in accordance with ISO 3126.

The tolerances on the outside diameters shall be in accordance with ISO 11922-1 as

Grade A for normal tolerance (NT pipes)

Grade B for close tolerance (CT pipes)

- **Length of pipe.**

The length of straight pipes & coils shall be not less than that agreed between supplier and user.

- **Finishes**

All internal surfaces of the pipes should be regular and smooth. The shape of the finished ends should be fixed by the manufacturer to suit the type of joint used.

- **Specials**

The specials should be manufactured from LDPE/Hard plastic, polyacetal split rings for positive grip and should sustain maximum working pressure 16 bar at 20° C. should be available in sizes 20mm (1/2”), 25 mm (3/4”).

The fittings should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his / sub contractor's premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

1.8.22.4 Ductile Iron Pipes

The DI pipes shall be centrifugally cast (spun) for Water and Sewage and conforming to IS 8329-2000. The pipes used shall be both gasket joints and flanged joints. The minimum class of pipe to be used shall be class K-9 conforming to IS 8329. In general, pipes inside the buildings and below the structures shall be jointed as double-flanged pipes and those outside the building can be either EPDM gasket in accordance with IS 5382 and manufactured by the pipe manufacturer only. The

pipes shall be supplied in standard lengths of 5.5m and 6.00m length with suitably rounded chamfered ends. Any change in the stipulated lengths will be approved by the Engineer's representative. The flanged joints shall confirm to the Clause 6.2 of IS 8329. The pipe supply will also include one rubber gasket for each flange.

Pump delivery piping & specials shall be double flanged type.

- **Inspection and Testing:**

The pipes shall be subjected to following tests for acceptance:

- (i) Visual and dimensional check as per clause 13 and 15 of IS 8329.
- (ii) Mechanical tests as per clause 10 of IS 8329.
- (iii) Hydrostatic test as per clause 11 of IS 8329.
- (iv) The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5382 and in accordance to clause 3.8

The sampling shall be as per the provisions of the IS 8329.

- **Markings**

All pipes shall be marked as per clause 18 of IS 8329 and shown as below:

- (i) Manufacturer name / stamp
- (ii) Nominal diameter
- (iii) Class reference
- (iv) A white ring line showing length of insertion at spigot end.

- **Packing and Transport**

The pipes should be preferably transported by road from the factory and stored as per the manufacturer's specifications to protect them from damage.

- **Specials for DI Pipes**

The DI specials shall be manufactured and tested in accordance with IS 9523 or BS 4772. The mechanical test and hydrostatic test shall confirm to clause 9 and clause 10 respectively of IS 9523. The tolerances on dimensions shall be as per IS 9523.

The manufacturer of the pipes shall supply the fittings.

All the DI fittings shall be supplied with rubber rings for each socket. The rubber ring shall conform to IS 12820 and IS 5382. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts.

1.8.23 Sluice Gates

The construction of sluice gates shall be in accordance with the specification and generally as per AWWA C 501 or IS 13349. The sluice gates shall be capable of performing the duties set in the specification without undue wear or deterioration. They shall be constructed so that maintenance is kept to a minimum. All parts of sluice gate, including mechanism components shall be designed for the heads specified with a minimum safety factor of five. All sluice gates shall be of the raising spindle type.

All sluice gates shall be manually operated. Motorised gates, if provided by the Contractor, the actuator specs be got approved from the Employer's representative.

- **Constructional features**

The sluice gates shall be standard design of manufacturer's and of robust construction. The special features shall be as follows.

- **Frame:**

The frames shall be of ample section and cast in one piece. All surface forming joints and bearings shall be machined. The frame shall be of the flange back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble.

- **Guide:**

The guide shall be bolted to the frame or cast integrally with it and shall be machined on all bearing and contact faces. The length of the guide shall be such that it should support the gate upon the horizontal line of stem nut pocket. Arrangements shall be such that it should support the gate upon the horizontal line of stem nut pocket. Arrangements shall be made to prevent lateral movement of

bolted on guides. They shall be capable of taking the entire thrust produced by water pressure and wedging action. Wedges or wedge facings shall be attached to the guides at point where, in the closed position, they will make full contact with the wedging surface on the slides.

- **Seating Faces**

The seating faces shall be of full width, solid section. They shall be secured firmly by means of counter sunk fixings in finished grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place as well as free from distortion and loosening during the life of the sluice gates.

- **Wedging devices**

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices required providing contact between the slide and frame facing when the gate is closed position. All faces shall be machined accurately to give maximum contact and wedging action. Wedges shall be fully adjustable with suitable adjusting screws and lock nuts and so designed that they will remain in the fixed position after adjustment.

- **Gate slides**

The slide shall be with strengthening ribs where required and reinforced section to receive the seating faces. The slide shall have tongues on each side extending its full length and tongues shall be machined accurately on contact surfaces. Surfaces of the slide that in come in contact with the seat facing and wedges shall be machined accurately. The maximum allowable clearances between the slide and slide gate shall be 1.6 mm. An integrally cast stem nut pocket with reinforced ribs shall be provided above the central line of the slide.

- **Stem nut and Lift nut**

A gate shall be provided with lower fixed stem nuts for connecting the stem to the slide and revolving lift nut located in the lifting mechanism in the head stock. They shall be of ample design to endure the thrust developed during gate operating under maximum gate operating condition loads in opening and closing direction.

The stem nut and slide shall be constructed to prevent turning of the stem nut in the pocket in the slide. The stem nut shall be threaded and keyed or threaded and pinned to the stem.

- **Stem**

The operating stem shall be designed for a tensile strength to withstand 90 kg effort on the crank and for a critical buckling compressive load assuming a 36 kg effort on the crank. The threads of the stem be machine cut or rolled and of the square or acme type. The number of threads per inch shall be such as to work most effectively with the lift mechanism used. The top of the stem be provided with a stop collar. Stem shall be provided with polycarbonate cover fixed to the headstock.

- **Stem coupling**

The coupling shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.

- **Stem guide**

Stem guides shall be cast, with bushings and mounted on cast brackets. Guides shall be adjustable in two directions and shall be so constructed that when properly spaced they shall hold the stem in alignment. The number of stem guides shall be such that the unsupported length of stem shall not exceed one hundred times its diameter.

- **Lifting Mechanism**

Sluice gates shall be operated through a suitable lifting mechanism, which shall incorporate gearing if required. The lifting mechanism shall be suitable for operation by one man under all conditions. The lifting mechanism shall incorporate a strong locking device suitable for use with a padlock or padlock and chain. The manual operation shall be of the hand wheel crank operated type and shall have a lift nut threaded to fit the operating stem. The crank shall be removable. Ball or roller thrust bearings shall be provided above and below flange on the lift nut to take the load developed in opening and closing the gate with torque of 14 kg-m on

the crank. Fittings shall be provided to lubricate gears and bearing. The design of the lift mechanism of the hand operated gates shall be such that the slide can be operated with torque is not more than 7 kg-m on the operator after the slide is unseated from wedges based on the operating head. The maximum crank radius shall be 380 mm.

- **Gears and bearings**

All gears and bearings shall be enclosed in cast iron housing with labyrinth seals. The lifting mechanism shall be of cast iron pedestal, machined and drilled to receive the gear housing and suitable for bolting to the operating floor. The gates shall close with clockwise rotation of the crank. The direction of rotation to close the gates shall be indicated on the lift mechanism. A suitable means shall be provided for lubricating the stem threads directly adjacent to the lift nut. An inspection cover shall be provided to access the lift nut and gearing.

- **Fasteners**

All anchor bolts, assembly bolts, screw, nuts etc., shall be of ample section to safely withstand the forces created by the operation of the gate.

- **Wall thimbles**

The wall thimbles shall be made of cast iron and shall be supplied along with the gate. The wall thimbles shall provide a rigid mounting and designed to prevent warping of the gate frame during installation. The cross section of the thimble shall have the shape of the letter 'F'. The front, or mounting flange, shall be machined and shall be attached to the thimble with bolts and studs. The depth of the wall thimbles shall not be less than 300mm. To permit entrapped air to escape as the thimbles are being encased in the concrete, holes not less than 35 mm diameter at not more than 600 mm span, shall be cast or drilled in each entrapment zone formed by the reinforcing ribs or flange and water stop.

- **Material of Construction**

Frame, Guide, Thimble, Stem

C I conforming to IS 210 Gr 260

Guide Bracket, Wedges,

Door Sealing faces	Bronze conforming to IS 318 Gr LTB 2
Spindle	SS AISI 431
Flush bottom resilient seal IS: 1855	Natural or synthetic rubber conforming to
Anchor bolts	SS conforming to IS 6603
Hand wheel	Cast iron
Stem cover	Polycarbonate transparent tube.

Parameters

Type	Rectangular rising spindle
Size	As per requirement
Applicable code	IS 13349
Class	1
Maximum seating head	As per contractors design
Unseating head	As per contractors design
Maximum distances between gates centre line and operating platform	As per contractors design.

Tests Seat clearance check, moving tests, leakage tests and Hydrostatic tests as per IS 13349/ AWWA C 501 shall be conducted at Manufacturer's works in accordance with the Inspection category.

1.8.24 Open channel Gates

The manufacture of open channel gates shall be in accordance with the manufacturer's standard. All open channel gates shall be of the rising spindle type. All open channel gates shall be manually operated or motorised as per process requirements. Open channel gates shall be tested as per manufacturer's standard. The open channel gates for pumping stations shall be CI sluice gates. The material of construction shall be as follows.

Components	Material	Specification	Grades

Contractor

No. of correction

Executive Engineer

Gate frame, shutter, Headstock, Flush bottom seal support bar, Stop nut.	Cast Iron	IS: 210 - 1993	FG: 260
Sealing faces/ Seat facings	Stainless Steel	ASTM A276	AISI: 304, 316
Resilient rubber seal	Natural Rubber EPDM Rubber Neoprene Rubber		
Seal retainer bar	Stainless Steel	ASTM A276	AISI: 304, 316
Stem / Spindle	Stainless Steel	ASTM A276	AISI: 304, 316
Operating Nut/ Stem Nut	Leaded Tin Bronze	IS: 318 - 1981	LTB 1, LTB 2
Fasteners	Stainless Steel	ASTM A276	AISI: 304, 316
Anchor Bolts	Stainless Steel	ASTM A276	AISI: 304, 316
Yoke	Mild Steel	IS: 2062 - 1992	Grade A

1.8.25 Chain Pulley Blocks

Geared Chain Pulley Blocks shall be adopted. The monorail and trolley and the chain pulley block shall be provided for lifting the blowers and submersible pumps. The trolley and chain pulley block shall be hand driven. The capacity of the trolley and the chain pulley block shall be for the maximum weight to be lifted during erection and maintenance of the equipment but should not be less than 1 tonne. The travelling trolley shall run on the lower flange of the rolled steel joist. The trolley shall have two wheels on both sides of the joist web. The trolley wheels shall be single flanged with treads machined to match the flange of the beam. The wheels shall be of carbon steel casting conforming to IS 1030. The trolley shall have an arrangement for the fixing chain pulley block and sling. Pushing the load shall move the trolley. Suitable arrangement shall be provided on the joist to prevent over travelling. The chain pulley block shall have frame housing gears load sheave, brake unit, hand chain wheel and load chain wheel shall have hooks on both sides, one fixed with traveling and other for the load. The frame shall be of welded construction.

The gears shall be of spur type incorporating high grade hardened carbon steel pinion and heat treated carbon steel wheels. The width of the gear shall be adequately sized for long life. The driving pinion shall be integrated with the

driving shaft. The load hook (bottom hook) shall rotate on the ball bearing. The chain shall be electrically welded, accurately calibrated, pitched and polished. The length of the load chain shall be sufficient for taking out the blower/pumps from their location. The hand chain wheel shall be provided with roller type guarding to prevent slipping the chain. The hand chain wheel shall hang to clear of the hook. The braking shall be automatic, the screw and friction disc type and shall offer no resistance. The load shall be sustained in any position of lift when effort for hoisting or lowering is removed. Each chain pulley block shall be supplied with one set of 1 tonne sling with galvanized D- shackles and clamps. The slings shall be about 3 m long. The monorail shall be 'I' section. The exposed mild steel surfaces shall be enamel painted. The fasteners shall be GI or Cadmium plated. The chain pulley block shall be tested for 150% overload through a length of lift which will ensure that every part of the block mechanism and every teeth of gears come under load.

1.8.26 Valve Actuators

All actuators shall be motorized type and local controls shall be protected by a lockable cover.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication. The valve actuator shall be capable of producing not less than 1½ times the required valve torque considering valve spindle jamming and shall be suitable for at least 5 continuous operations.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.

The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation.

Heaters shall be suitable for single phase operation. The heaters shall be switched “ON” when the starters are “OFF” and shall be switched “OFF” when the starters are “ON”.

Each actuator shall be equipped as follows:

- (a) AC electric motor with engage/disengage clutch mechanism of the dry type.
- (b) Reduction gear unit (with thrust bearing if required)
- (c) Torque switch mechanism
- (d) Limit switch mechanism
- (e) Geared hand wheel for manual operation of valve.
- (f) Valve position indicator - open/closed
- (g) Auto-Manual lever with suitable locking arrangement
- (h) Reversing contactor starter complete with overload relays of suitable range and adequately rated control fuses
- (i) Actuator shall have selection between local/remote operation
- (j) Local control switch/push buttons
- (k) 415 V/110 V AC control transformer
- (l) A white lamp for supervision of main supply to be provided locally.
- (m) A potential free contact shall be provided to annunciate over-load trip/main supply failure on remote panel
- (n) Provision for local as well as remote operation

1.8.27 Laboratory Equipment

Laboratory equipments shall be provided as mentioned below (each location):

Sr · N o	Item Description	Uni t	Qt y
A	Laboratory Instruments		
1	Digital Spectrophotometer	No.	1
2	Cuvette 50mm	No.	1

Contractor

No. of correction

Executive Engineer

3	Cuvette 10mm	No.	2
4	Digital Nephelometer	No.	1
5	T D S meter	No.	1
6	Magnetic Stirrer	No.	1
7	Hot Plate with regulator	No.	1
8	Autoclave portable	No.	1
9	Digital pH meter	No.	1
10	Distilled water plant	No.	1
11	Vacuum Desiccator	No.	1
12	Vacuum Pump	No.	1
13	Centrifuge	No.	1
14	Microscope	No.	1
15	Digital Colony Counter	No.	1
17	Water Bath Thermostatic	No.	1
18	Digital Muffle Furnace	No.	1
19	Lab. Oven	No.	1
20	Bacteriological Incubator	No.	2
21	B.O.D. Incubator, made by Refrigerator	No.	2
22	Single Pan Balance	No.	1
23	Inoculation Chamber	No.	1
24	Gas stripping Apparatus	No.	1
25	Membrane filter Assembly	No.	1
26	Membrane filter Disc	No.	1
27	Heating Mantle	No.	1
28	Fume Hood	No.	1
29	Thermometer with calibration	No.	1
30	Kjeldahl Distillation Assembly	No.	1
31	Flow Meter	No.	1
32	Reduction Column	No.	1
33	Activated Carbon Column	No.	1
34	ERTL Approved calibration Certificate	No.	10
B	Laboratory Glassware		
1	Amber coloured bottle, 1000ml	No.	4
2	Amber coloured bottle, 500ml	No.	10
3	Amber coloured bottle, 250ml	No.	12
4	Amber coloured bottle, 125ml	No.	6
5	Plain wide mouth bottle, 1000ml	No.	1
6	Plain bottle, 1000ml	No.	4
7	Plain bottle, 500ml	No.	10
8	Plain bottle, 250ml	No.	52
9	Plain bottle, 125ml	No.	6
10	Beaker, 1000ml	No.	2
11	Beaker, 500ml	No.	4
12	Beaker, 250ml	No.	4
13	Beaker, 100ml	No.	4
14	Beaker, 50ml	No.	2

Contractor

No. of correction

Executive Engineer

15	Plastic Beaker, 500ml	No.	3
16	Plastic Beaker, 250ml	No.	3
17	Measuring Cylinder, 500ml	No.	3
18	Measuring Cylinder, 250ml	No.	2
19	Measuring Cylinder, 100ml	No.	1
20	Volumetric flask, 500ml	No.	4
21	Volumetric flask, 250ml	No.	4
22	Volumetric flask, 100ml	No.	8
23	Grouch crucible G-4	No.	1
24	Grouch crucible G-3	No.	1
25	Silica dish	No.	1
26	Filter funnel	No.	4
27	Screw capped tube, 50ml	No.	12
28	Screw capped tube, 30ml	No.	12
29	Nessler's Cylinder, 100ml	No.	8
30	Durham's tube	No.	3
31	Test tube, 20ml	No.	60
32	Test tube, 10ml	No.	15
33	Round bottom flask, 500ml	No.	1
34	Round bottom flask, 100ml	No.	3
35	Flat bottom flask, 500ml	No.	1
36	Flat bottom flask, 250ml	No.	3
38	Separating funnel, 500ml	No.	2
39	Separating funnel, 125ml	No.	4
40	Separating funnel, 1000ml with Teflon	No.	1
41	Dropper	No.	4
42	Glass rod	No.	10
43	Graduated pipette, 25ml	No.	3
44	Graduated pipette, 2ml	No.	2
45	Petri plate 4"	No.	60
46	Conical flask, 500ml	No.	3
47	Conical flask, 250ml	No.	3
48	Iodine flask, 250ml	No.	2
49	Condenser	No.	2
50	Burette, 50ml	No.	3
51	Boiling Beads	Kg	0.5
52	Watch Glass	No.	2
53	Cover Slip	No.	2
54	PP Measuring Cylinder, 100ml	No.	2
55	PP Conical flask, 250ml	No.	2
56	PP bottle 250 ml	No.	6
57	Tripod Stand	No.	2
58	Wire gauge	No.	10
59	Watman filter paper No. 1/2	No.	1
60	Watman filter paper No. 40/42	No.	1
61	Test tube stand	No.	1

Contractor

No. of correction

Executive Engineer

62	Pipette stand round	No.	1
63	Burette Stand	No.	1
64	Non absorbent cotton	No.	2
65	SS Spatula	No.	2
66	SS Tong	No.	2
67	Test tine	No.	2
68	Tissue role	No.	2
69	Gas burner	No.	2
C	Laboratory Chemicals		
1	Ammonia buffer soln.	ml	500ml
2	Activated charcoal	gm	500gm
3	Ammonium Dichromate	gm	500gm
4	Ammonium acetate	gm	500gm
5	Ammonium chloride	gm	500gm
6	Ammonium hydroxide	gm	500ml
7	Antimony metal powder	gm	500gm
8	Azomethane H	gm	2gm
9	Acetic acid Glacial	ml	500ml
10	Ammonium oxalate	gm	500gm
11	Aluminium potassium sulphate	gm	500gm
12	Ammonium carbonate	gm	500gm
13	4 - Aminino antipyrine	gm	25gm
14	Acetone	ml	500ml
15	Ascorbic acid L	gm	100gm
16	Buffer tbt 4.0	tbt	10tbt
17	Buffer tbt 7.0	tbt	10tbt
18	Bensene	ml	500ml
19	Boric acid	gm	500gm
20	Barium chloride	gm	500gm
21	Barium hydroxide	gm	500gm
22	Calcium chloride	gm	500gm
23	Cobaltous chloride	gm	100gm
24	Chlorotex Reagent	ml	100ml
25	Citric acid	gm	500gm
26	Cyclohexanone	ml	500ml
27	Calcium hydroxide	gm	500gm
28	Copper metal powder	gm	500gm
29	Chloroform	ml	500ml
30	Cupric sulphate	gm	500gm
31	Chromotropic acid	gm	25gm
32	Dodecyl benzene sulphonc acid	gm	500gm
33	Di ammonium hydrogen orthophosphate	gm	500gm
34	Ethyl acetate	ml	500ml
35	Ethanol	ml	500ml
36	E D T A	gm	100gm
37	Erichrome Cyanine R	gm	5gm

Contractor

No. of correction

Executive Engineer

38	Ferric chloride	gm	500gm
39	Ferric citrate	gm	500gm
40	Ferrous ammo sulphate	gm	500gm
41	Formaldehyde	ml	500ml
42	Gelatin powder	gm	500gm
43	Glycerine	ml	500ml
44	Hydrazine sulphate	gm	100gm
45	Hexamethylene tetramine	gm	500gm
46	Hydrochloric acid	ml	500ml
47	Hydrogen peroxide	ltr	1ltr.
48	Hydroxylamine Hydrochloride	gm	100gm
49	Iodine resublimed	gm	100gm
50	Iso Propyl alcohol	ml	500ml
51	Methanol	ml	500ml
52	Mercuric chloride	gm	250gm
53	Neocuprone (2, 9 dimethyl 1, 10 (N1-naphthyl) ethylene dihydrochloride	gm	1gm
54	NED dihydrochloride		5gm
55	Nitric acid	ml	500ml
56	N,N dimethyl - P - Phenylene diamine oxalate	gm	5gm
57	Orthophosphoric acid	ml	500ml
58	Potassium chloroplatinate	gm	1gm
59	Potassium iodine	gm	250gm
60	Perchloric acid	ml	500ml
1	Potassium dichromate	gm	500gm
62	Potassium chromate	gm	500gm
63	Potassium nitrate	gm	500gm
64	Potassium permangate	gm	500gm
65	Patton & Reeders indicator	gm	5gm
66	Potassium cyanide	gm	5gm
67	Phenol crystal	gm	500gm
68	Potassium bromate	gm	500gm
69	Potassium bromide	gm	500gm
70	Potassium dihydrogen phosphate	gm	500gm
71	Potassium ferricyanide	gm	100gm
72	Potassium chloride	gm	500gm
73	Potassium metaperiodate	gm	100gm
74	1, 10 Phenanthroline	gm	5gm
75	Potassium hydroxide	gm	500gm
76	Rhodamine B	gm	25gm
77	Sodium acetate	gm	500gm
78	Sodium hydroxide	gm	500gm
79	Sodium chloride	gm	500gm
80	Sodium thiosulphate	gm	500gm
81	Sulphuric acid	gm	500ml
82	Sodium hydrogen carbonate	gm	500gm

Contractor

No. of correction

Executive Engineer

83	Sodium carbonate	gm	500gm
84	Sodium sulphate	gm	500gm
85	Starch soluble	gm	500gm
86	Silver nitrate	gm	25gm
87	Sodium sulphite anhydrous	gm	500gm
88	Sodium ascorbate	gm	100gm
89	Sulphur dioxide solution	gm	500ml
90	Sodium fluoride	gm	500gm
91	Sodium metabisulphate	gm	500gm
92	Sodium nitrite	gm	500gm
93	Sodium oxalate	gm	500gm
94	Sucrose	gm	500gm
95	Sulphanilamide	gm	500gm
96	Tri sodium citrate	gm	500gm
97	Tri ethanol amine	gm	500ml
98	1, 1, 2 trichloro trifluoro ethane	gm	250ml
99	Urea	gm	500gm
100	Zinc dust	gm	500gm
101	Zincon	gm	1gm
102	Zinc sulphate heptahydrate	gm	500gm
103	Zinc acetate	gm	500gm
D	List Of Media		
1	Aspergine praline broth	gm	100gm
2	Andrade peptone water	gm	100gm
3	Brilliant green bile broth 2%	gm	100gm
4	Chloramphenicol yeast glucose agar	gm	100gm
5	Differential reinforced clostridial medium	gm	100gm
6	EMB Agar	gm	100gm
7	Lactose broth	gm	100gm
8	MacConkey's broth	gm	100gm
9	MacConkey's agar	gm	100gm
10	Milk agar with cetrimide (Twin)	gm	100gm
11	MR-VP Medium	gm	100gm
12	Nutrient broth	gm	100gm
13	Nutrient agar No. 2	gm	100gm
14	Peptone water	gm	100gm
15	Plate count agar	gm	100gm
16	Simmon's Citrate agar	gm	100gm
17	Tergitol - 7 agar base	gm	100gm
18	Violet red bile agar	gm	100gm
E	list of Indicators		
1	Brilliant green	gm	25gm
2	Bromocresol purple indicator	ml	125ml
3	Bromocresol green	ml	125ml
4	Crystal violet	ml	125ml
5	Eosin	ml	125ml

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6	Methyl orange	ml	125ml
7	Methyl red	ml	125ml
8	Methylene blue	ml	125ml
9	Muraxide (Ammono Purpurate)	gm	5gm
10	Neutral red indicator	ml	125ml
11	Phenol phthalein indicator	ml	125ml
12	Erichrome black T	gm	25gm
13	Universal indicator	ml	125ml
14	Phenol red	ml	125ml
15	Gram iodine stain	ml	125ml
16	Bromothymol blue	ml	125ml
F	Providing Furniture for The Laboratory		Qty.
1	Providing, manufacturing & supplying Working table of approx. size 1200mm X 600mm & 750mm height with 4 Drawers of 300 mm width, in marine plywood finish with inside the drawers including all hardware etc. complete		3 Nos.
2	Providing, manufacturing and supplying Side table of specifications same as working table but along wall.		4 Nos.
3	Providing, manufacturing and supplying Running table of specifications same as side table but along wall and 450 mm deep.		2 Nos.
4	Providing, manufacturing, supplying and fixing Storage unit above the running table in marine plywood of approx. 450mm deep and 600mm height with shelves, shutters including all hardware, 1.5mm thick laminate on External face & wax polish internally.		2 Nos.
5	Office Chairs		4 Nos.
6	Steel Almirah		2 Nos.

**TECHNICAL SPECIFICATIONS: ELECTRICAL &
INSTRUMENTATION WORKS - PART A**

1.1 TRANSFORMERS

Contractor

No. of correction

Executive Engineer

1.1.1 General

a) Standard Specification of Electrical Works

Transformer

The specifications given below refers to the design, manufacture, testing and supplying of step down core resin impregnated **dry type** indoor transformer.

Standards:

- a) The design, manufacture and performance of equipment shall comply with all currently applicable standards, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be constructed to relieve the Vendor of this responsibility.
- b) Unless otherwise specified equipment shall conform to the following latest applicable Indian Standards.

IS:11171 - Transformer

IS:3639 - Fittings and Accessories for Power Transformer

IS:2099 - High Voltage Porcelain Bushings

IS:3637 - Specification for Gas Operated Relays

System of Supply: 11 KV, 3 phase, 50 cycle solidly earthed system.

Rating: Suitable for operation at peak load for continuous rating

No Load voltage: 11000 Volts on H.V. side and 433 Volts on L.V.side,

11000/433 Volts.

- Winding shall be subjected to shrinking and seasoning process, that, no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.
- Materials used in the insulation and assembly of the windings shall have high tensile and dielectric strength. These shall not soften or otherwise get affected under the operating conditions.
- In case of Dy-11 transformers, neutral shall be brought out in open for solid earthing on the secondary side.
- The windings shall be copper wound.

Enclosure:

Steel enclosure with screens of metal at top for indoor type transformer shall be provided. For outdoor type transformer, hermetically sealed unit should be used.

Impregnation:

- Coils to be impregnated with cycloaliphatic epoxy resin by vacuum pressure impregnation process to ensure void free impregnation.
- The process shall consist of but not limited to preheating, vacuum drying, under vacuum entry of resin, vacuum submersion, pressurization, draining, transfer to oven and curing.
- Class of Insulation: Type "H"

Tapings:

Off load tap changing arrangement on H.V. side, The tapings to be provided for variation of H.V. voltage from +5% to -7.5% in steps of 2.5%, with arrangement to lock with pad including 2 sets of keys.

Temperature Rise:

Continuously rated for full load, temperature rise not to exceed 115⁰C over ambient.

Cooling:

Natural air cooling.

Fittings:

The following accessories and fittings shall be provided with the transformers:

a) Inspection covers:

Inspection cover on top of the transformer shall be provided.

b) Lifting lugs:

The arrangement of lifting the active part of the transformer along with the cover of the tank by means of lifting lugs without disturbing the connections. Also complete transformer lifting lugs shall be provided. Lifting arrangement for core and coils shall also be provided.

c) Jacking pads:

Jacking pads shall be provided on the transformer.

d) Earthing pads:

Two nos. earthing pads shall be provided of copper of non-corrosive material on transformer enclosure and suitable earthing terminals on cable boxes.

e) Diagram and rating plate:

One diagram and rating plate indicating the details of transformer, connecting diagram vector group, tap changing diagram etc. shall be provided.

f) Rollers:

4 Nos. bi-directional type roller shall be provided to the transformers on cross channels to facilitate the movement of transformers in both the directions.

g) Temperature Indicator:

Winding temperature indicator with contacts for operating trip circuits as well as for alarm shall be provide.

Cable End Boxes:

a) On H.V. Side:

Cable end box suitable for 11 KV, 3c x 120 sq.mm (minimum) XLPE cable. The size of box should be sufficient for termination using cable jointing kit.

b) On L.V. Side:

On L.V. side cable end box shall be providing suitable to accept the following size cables.

8 Nos. XLPE insulated and overall sheathed armoured, aluminium conductor cables of size 1 c x 400 Sq. mm. (minimum)

The cable terminal box shall be provided with suitable cable glands of proper size and number of lungs shall be provided on the terminal for all cables.

Testing:

The transformer shall be subjected to the following tests at the factory before dispatching the same and test certificates, in quadruplicate, shall be furnished:

- a) Measurement of winding resistance.
- b) Ratio polarity and phase relationship
- c) Impedance Voltage
- d) Load Losses.
- e) No load loss and no load current
- f) Insulation resistance
- g) Induced over voltage withstand

- h) Separate source voltage withstand
- i) Temperature rise by no load plus short circuit method

Instruction Manual:

The contractor shall submit six copies of manual of complete instructions for the installation, operation, maintenance and repairs, circuit diagram and foundation details shall be provided with the transformers.

Drawings:

a) Four sets of drawings of the transformers being supplied shall be furnished within two or three weeks of placement of order for approval.

The routine and other tests to be performed as per IS: 11171-1985 and IS:2026-1977.

b) It shall have HV cable box. For Transformer of 1000 KVA and above, bus duct shall be used in LT side whereas for transformer below 1000 KVA, cable box shall be provided in the LT side. Radiators shall also be detachable type along with HT cable boxes and disconnecting chamber on HT side.

c) Transformers shall employ copper conductor windings.

d) Transformers in clause (b) above shall have a separate bushing brought out on the transformer tank for earthing of neutral. Transformers designed for HV cable connections shall incorporate disconnecting chambers.

e) Transformers in clause (a) above shall have off load tap changing gears with auto / manual operating features. The tap changer range shall be -10% to + 5% in steps of 2.5%. The voltage profile of the transformer shall confirm to the voltage profile of power distribution agency. Transformers in clause (b) above shall have off load tap changers.

f) The Transformer KVA rating shall be designed considering maximum 80% loading on the transformer at full load with a power factor of 0.8. No. Of transformers shall be 2 nos each of 100% of total plant load.

1.2 REQUIREMENT FOR OTHER ELECTRICAL ITMES:

1.2.1 Painting:

a) Rust in the sheet steel, structural steel used for fabrication shall be removed by pickling with dilute acid followed by washing with running water, rinsing with

slightly hot water and drying. A lightweight zinc coating to class C as per relevant IS shall be applied. After phosphating thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and drying. After pre treatment, powder coats of thickness not less than 50 microns shall be applied.

b) Paint shade for all electrical equipment shall be 692 (smoke grey shade) and 631 (admiralty grey) for indoor and outdoor equipment respectively. Unless specifically instructed interior portions of all housings shall be painted with white colour. Paint shade references are as per relevant IS.

1.2.2. Sheet Metal Work:

Sheet steel used for fabrication of these or similar items shall be cold rolled sheet of 2 mm or hot rolled sheet of 2.5 mm. All cubicles, panels, cabinets, kiosks and boards shall comprise rigid welded structural frames made of pressed and formed sheet steel thickness of not less than 2 mm cold rolled or 2.5 mm hot rolled. The frames shall be enclosed by steel sheets thickness of at least 2 mm cold rolled or 2.5 mm hot rolled, smoothly finished and free from flaws. Stiffeners shall be provided wherever necessary. All doors, panels, removable covers, gland plates, etc. shall be gasketed all round the perimeter. Locking arrangement for doors / removable covers/ panels shall be hand operated type requiring no tools for locking or unlocking. Padlocking facilities where required shall be provided in addition to above along with padlocks and duplicate keys.

All doors shall be removable and supported by strong hinges of the disappearing or internal type and braced in such a manner as to ensure freedom from sagging, bending and general dislocation of panel of hinged parts. The hinges should be in such a fashion that door once hooked in upper hinge automatically slides in the bottom hinge. Suitable compartment shall be made for mounting switchgear and compartment shall be fully isolated from other compartment.

1.2.3. Switchgears:

1.2.3.1. LV Switchgears:

415 V switchgear shall comprise separate, segregated modules for each circuit

in compartmentalized fashion for PCC and MCC with starters capacity > 50 HP. More than one module may not be arranged in the same compartmentalized section. Medium voltage switchgear circuits controlled by circuit breakers shall be of draw out type. It shall not be possible to obtain access to an adjacent cubicle when any door is opened. Each door shall be interlocked and all line terminals, bus bar chambers & back covers must be shrouded between each vertical riser and there should be proper barriers. Not more than one air circuit breaker shall be mounted in one vertical bay Bus bars and cableways in 415 V switchgear shall run in separate segregated compartments and again these should be isolated from equipment chamber making minimum form 3B construction. Instruments, relays and control devices shall be mounted flush on hinged door of the metering compartment located in the front portion of the cubicles.

1.2.3.2. Circuit Breakers:

a. General:

The circuit breaker shall be air break type with draw out design confirming to the relevant Indian standards. All the circuit breakers of the panel will be mounted in separate cubicles and will be of same make to maintain the uniformity.

The breakers will be draw out type and will be mounted on a rigid steel frame moving on horizontal ball, telescopic slides offering minimum of friction. The system will have horizontal, self-aligning, isolating pairs of moving and stationary power and control contacts. The unit will have three horizontal positions corresponding to:

b. Plugged In Position:

Here both the Power and control contacts are in make position and the breaker gets mechanically locked in this position. The breaker can go in ON position only after being locked in this position.

c. Test Position:

Here the power contacts get isolated where as the control contacts can be kept in make status. The breaker can be mechanically locked in this position and make ON and OFF for testing purposes.

d. Withdrawn Position:

In this position the power and control connections are in isolated status and the moving portion of the breaker can be dismantled from the panel. An isolating shutter or set of shutters is to be provided for the automatic coverage of live power and control fixed isolating contacts in the withdrawn position.

All the breakers with remote closing arrangement will have a spring charging motor of single phase 230 V and a closing coil. In case of power failure the spring charging can be done manually with the help of button or lever. The circuit breaker should switch on only when the spring is charged fully which should be able to store energy for one closing and one tripping operation. The spring will also get fully charged when the breaker is in closed position. In this case the spring should store enough energy to make first tripping, one re-closing and the second tripping.

The breaker will have quick making trip free closing mechanism. The operation of the mechanism will be independent of the speed of the closing lever or the duration of the closing signal.

The breaker will have following indications distinctly notable from outside.

- Electrical indication of breaker ON status.
- Electrical indication of breaker OFF status.
- Electrical indication of trip circuit healthy.

All breakers will have switching ON and OFF time of less than 4 cycles and will have the following interlocks for the safe operation of the equipment:

- Breaker to ON only when mechanically locked in any of the three horizontal isolation position.
- When the Breaker is in "Plugged in" position it will go to ON position only with the front door closed.

The breakers will be provided with 6 Nos each of type NO and NC auxiliary contacts rated for 10 Amps AC at 415 V and 6 Amps DC at 48 V. These contacts are in addition to the ones already in use for the operation of the breaker and will be required for subsequent interlocks incorporated in near future.

Whenever requested mechanical positive interlocks will be provided between the operation of different breakers with the help of individually unique and suitable Castle Key Locks.

1.2.3.3. Isolators Switches, Fuse Units & Fuses:

These items shall conform to the latest IS13947 and following specifications:

- a. The isolators and switch fuse units (SFU) will be three pole or four pole air break double isolating type capable of making and breaking the current as detailed below without any abnormal deterioration in the life of equipment and without endangering the safety of the operators. Wherever isolable neutral is specified, neutral is terminated / isolated separately. Wherever switched neutral is specified, four pole switches will be used. All switches will be fully shrouded and a proper barrier plate will be used between phases.
- b. In case of isolator/SFU supplying heater, lighting loads etc., the current is of 125% of full load current connected.
- c. In case where the switch is supplying current to a group of motors this capacity of the isolator/SFU will be equal to full load current of all motors plus the locked rotor stator current of the largest motor of the group.
- d. In case of the load being capacitors this capacity of the isolator/SFU is equal to 225% of the capacitor current.
- e. In case of the DB^s, SFU panel etc. the isolator/SFU will be mounted on the component plate of the module and the operating handle will be brought out for front access to enable the operation. The operation of the isolator/SFU will be interlocked with the isolator/ SFU in ON and OFF positions will be provided. Clear indications of ON and OFF positions of the handle will be shown on the front door for confusion free evaluation of the status of the isolator/SFU.
- f. The operating mechanism of the isolator/SFU will be quick make, quick break type and it's speed of operations will be independent of the speed of the operating handle.
- g. The isolator/SFU will be able to carry short-circuit current 1for 10 cycles before the fault is cleared by the local/ remote fuses/breaker.
- h. The SFU will have three fuses one in each phase to provide safety against high currents.The fuses will be only High rupturing capacity (HRC) type. The fuses should be capable of clearing the fault current on short circuited

without damaging the isolator/ switch and without endangering the safety of the operator and the adjacent equipment.

- i. All the control fuses and the power fuses will be HRC type with current rupturing capacity of more than 41 KA at 440 V AC. No wire fuses or any other kind of fuses shall be used in the supply of electrical equipments for this project.
- j. Shall have very high mechanical life e.g. 10000 operations for 800A.
- k. Manufacturer to confirm that equipments have been tested as per IS13947.

1.2.3.4. Contactor Type Motor Starters:

Motor starter / contactor shall be of the electromagnetic type rated for uninterrupted duty. Contactors of DOL and star / delta starters shall be suitable for class AC 3 utilization category and contactor for reversing starters shall be of AC 4 category. Contactors used for star / delta and forward / reverse shall be electrically interlocked. Main contacts of the contactors shall be silver faced. Operating coils shall be suitable for operation on 230V, 1 Phase, 50 Hz supply. Each contactor shall have minimum 2 Nos + 2 NC auxiliary contacts for interlocking and control circuits. Contactors shall have very high electrical & mechanical life and size shall confirm to only type II coordination. At least one spare 1 NO + 1 NC shall be provided for future use after using all control contacts for interlocking, control circuit in PLC/ DDC logics, indication and controls.

1.2.3.5. Overload Relay:

All the Over load relays used for the protection of three phase induction / synchronous motors will be three elements, ambient temperature compensated, positive acting, manual reset, as well as auto reset from panel front, heavy duty, separately mounted, bimetallic thermal type relays with one change over contact rated for 6 amps at 415 V AC. The resetting of the relay will be done by a push button located on the front door with the help of movement transfer by a flexible shaft in flexible cable outer between the push actuator and the relay reset point. The relay shall have single phasing prevention feature and shall be as per latest amended relevant IS. If due to PLC logic, more changeover NO/NC contacts are required then either relay shall have more changeover contacts or basic

changeover (along with the relay) shall be multiplied to obtain extra contacts. The rating of these contacts should be rated for at least 2 times the current requirement.

For the equipment having higher inertia special arrangements will be made to short circuit the relay with or without resistance, with the help of a contactor and a timer. The shorting contactor will open after laps of a preset time (Set on the timer) after the starting.

The adjustment range of the over load relay shall cover 70% and 110% of the full load currents of the motor it is protecting.

All motors of 100 H.P. and above shall have additional protection of earth leakage through core balance current transformers and winding temperatures shall be displayed. For these motors of 100 H.P. and above, the numeric type micro-processor based relays shall be used in place of conventional thermostatic overload relays.

1.2.3.6. Moulded Case Circuit Breaker

Molded Case Circuit Breakers shall comply with IS-13947 and have a category of duty P2. They shall be of the low energy let through type incorporating positive ion quenching in order to ensure rapid arc quenching i.e. shall be of extra current limiting feature. It shall have provision of adding either one-shunt trip or under voltage along with two changeover contacts at any stage.

The operating faceplate shall have three positive positions 'ON', 'OFF' and 'TRIPPED' and this shall be used with front extended rotary handle. All contacts shall have phase barrier and extended links for aluminum suitability.

Tripping characteristic shall be of ambient temperature compensated and selected according to application, i.e. distribution, generation or motor duty. The size of MCCB shall be selected after taking necessary de-rating into account inside panel compartment. It shall have variable over current setting and variable short circuit setting.

1.2.3.7. Miniature Circuit Breaker:

Miniature circuit breaker (MCB) shall have 10 KA breaking capacity. If fault withstand capacity of MCB is less than that of the switchboard, backup HRC fuse or motor protection circuit breaker shall be fitted. MCB shall conform to latest IS 8828 : 1996 and shall have lower watt losses and shall be rated for 10 KA and type 'C' Curve shall be used.

1.2.3.8. Residual Current Circuit Breaker

Residual current circuit breaker shall be current operated and comply with IS 12640 or BS 4293. The tripping current shall be selected dependent on location within the supply network and the calculated loop impedances. It shall operate to trip all phases including the neutral. **Unless otherwise specified the following sensitivities shall be applied:**

- Individual ring mains, ring main group or socket outlets 30mA
- Small consumer boards incorporating no other RCCB protection 30mA
- Small consumer boards incorporating RCCB protection on outgoing way 100mA
- Large consumer board incoming RCCB shall be at least 300 mA

The residual current circuit breaker shall be capable of withstanding the likely fault current at the point of installation.

1.2.4 Bus Bars:

Switchgears shall be provided with three phase or three phase and neutral bus bars. Bus bars shall be of aluminum and shall be insulated with close fitting fiber reinforced plastic sleeve. PVC sleeve shall be acceptable for LV switchgear. Insulating sleeves shall have R, Y, B, colour bands at suitable intervals for identification of phases and shall withstand 90 ° C temperature. Bus bar used shall be Al 91E with minimum 55% conductivity. Bus bar will be designed for 500V with neutral bus bar size shall be half of phase. Bus bar sizes will be uniform throughout horizontal run and again uniform on the vertical run. No reduction of bus bar size is permissible either in horizontal or vertical run and uniform life of busbar shall be adopted.

All bus bar joints and bus tap joints shall be plated. Bus bar joints shall be of

the bolted type and shall be insulated with moulded caps. To provide a tight seal between adjacent cubicles, bus bars shall be taken through seal off bushings or insulating blocks.

Bus bars shall be adequately supported on insulators capable of withstanding dynamic stresses due to short circuit. The short circuit rating of bus bars shall not be less than that of the associated switchgear and bus bar ratings shall be worked out after taking deratings of ambient temperature and enclosure. Bus bar temperature shall not rise beyond 85⁰ C. Bus bar temperature rise calculations, short circuit calculations along with the Employer support distance shall be submitted at detailed engineering stage for approval alongwith temperature rise and minimum size of busbar selected. Similar calculations must be submitted for earth bus.

1.2.5 Interlocks:

Interlocks for LV circuit breakers shall comply with the following requirements:

- a) It shall not be possible to plug in or isolate a closed circuit breaker. Attempted isolation of a closed circuit breaker from switchgear cubicle / module shall trip the circuit breaker.
- b) It shall not be possible to close a circuit breaker unless it is in “service”, “test”, or “isolated” position.
- c) Isolating devices, if provided shall be interlocked with breakers to prevent their making or breaking current.
- d). It shall not be possible to close the circuit breaker in service position, without completing the auxiliary circuits between fixed and moving portions.
- e) Where key interlocking is employed tripping of a closed circuit breaker shall occur if any attempt is made to remove the trapped key from the mechanism.

1.2.6 Test Operation Facilities:

A separate test position of the breaker shall be provided in the cubicle / module. It shall be possible to test the breaker in this position with all interlocks in the circuit.

1.2.7 Safety Shutters:

Switchgear cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn.

1.2.8. Switchgear Control Components, Devices and Other Features:

All individual components of control equipment associated with any item of pumping station shall be contained in a single control cubicle or panel.

All instruments, relays, switches, lamps, push buttons and the like shall be arranged on the cubical in a neat, functional and logical manner. The arrangement shall be subject to the Employer approval.

Similar items shall be of the same type, style pattern or appearance throughout. Control and changeover selection switches for various functions shall be of the same type but with a handle of different shape for each specific function.

Instruments, control devices and relays mounted on different panel sections but having similar functions shall be located in a physically similar position. Such equipment shall be mounted at a operating height not exceeding 1800 mm and not less than 300 mm operating height above floor level.

1.2.8.1. Indicating Meters:

All indicating meters shall be digital type complete with inter-facing devices.

- a) Display : 4-1/2 Digits, 7 segments red coloured LED
- b) Accuracy : $\pm 1\%$
- c) Inputs : From current transformer /voltage transformer as required.
- d) Dimension of digits : 12.5 mm (Minimum)
- e) Sampling rate : 4 samples / sec

1.2.8.2. Indicating Lights:

Indicator lights shall be not less than 20mm diameter and shall be panel mounted types with metal bodies adequately fastened so that the lamps shall be capable of replacement from the apparatus without disturbance to the lamp holder or panel wiring. Lamp holders shall be keyed into panels to prevent rotation. Lens colours shall comply with BS EN 60037 as follows:

- Power on White*
- Running Green
- Tripped/ alarm Red
- Status (open, closed, etc) Blue
- Ready to start Blue
- Warning (no imminent danger) Amber

Note: *white may be used where doubt as to which other colour to use.

The Lights shall be under-run to give long life either by use of a resistor to limit voltage to 90% normal value or by using higher voltage lamps. The indicating lamps on control panel shall be cluster of LED's.

1.2.8.3. Push buttons:

Colours of push buttons shall generally comply with IS 6875, BSEN 60947, 60037 or IEC 60073 and in particular shall be as follows:

- Stop, emergency stop Red
- Start Green
- Jogging/ inching Black
- Reset (when not also acting as a stop) Blue
- Lamp test Blue
- Override/ alarm accept Yellow

1.2.8.4. Control Transformers:

Unless otherwise specified all control circuit supplies for contractor starters shall be obtained from a 230V, 50 Hz integral control transformer contained in the breaker or starter cubicle. In the case of motor control centers and composite boards comprising circuit breakers and starters one or more master control circuit transformers shall be provided for each section of busbars in the switchgear to feed a group of outgoing starters and / or outgoing breakers via bus wires in the board. Each control transformer shall be busbar connected and be provided with isolation facilities, and primary and secondary HRC fuses. Transformers shall be of the double wound pattern and be provided with earth screen between primary and secondary windings. One end of the secondary winding shall be earthed through a

link. Each control transformer will have 100% standby and a manual change over arrangement between two control transformers.

1.2.8.5. L.T Current Transformers (CTs):

The current transformers to be used in the L.T. Electrical panels shall be low tension, ring/ rectangular type resin cast current transformer with the requisite currents ratio having secondary of the current transformers. For guidance the protective current transformers shall have an accuracy class 5P and an accuracy limit factor greater than 10. Low reactance current transformer shall be used for protection. Selection will be based on the following information:

- a) For energy measuring : 1.0 class of accuracy.
- b) For other metering : 1.5 class of accuracy.
- c) For protection : 5P10 class of accuracy.

The current transformers to be selected for this panel will have at least 20% extra VA capacity available over the normal conventional meter capacity based on the following details:

- For ammeters conventional : 3 VA.
- For current coils of KW & KWH : 5 VA
- For current coils of PF.KVAR meters : 5 VA
- For all recorders conventional : 5 VA
- For normal wiring : 2 VA
- For current coil of protection relays : 10 VA.

The VA rating shall be calculated keeping 30% spare capacity and under no circumstances the VA rating of the CT's will be less than 15 VA. In case of low currents a primary wound CT will be chosen or a higher size ring type CT with 2 or 3 or 4 or 5 turns of primary conductor may be used to get the VA rating at required current ratio.

1.2.8.6. Terminal Blocks:

Terminal boards or block shall be of barrier pattern, stud type having covers of transparent insulating material.

All terminals shall bear a permanent identification number of letter. Terminal

blocks shall be of 650 V grades, 10A rated.

Dropping type shorting links shall be provided on terminal block for CT secondary shorting. Terminals used in conjunction with current transformer shall have facilities for shorting out of the output to enable removal of instrumentation.

Terminal blocks shall be of the screw clamp, rail mounted type to IS: 13947, VDE 0611 : Part 1 for connection of copper conductors up to 1000V.

The terminals used shall be suitable for the type of wire to be terminated and current carrying capacity.

Each terminal rail and each individual terminal shall be indelibly marked with a unique number corresponding to the schematic numbering system.

No more than two cables shall be terminated per clamp. Cross connections shall be used to link adjacent terminals where multiple wire connections are required.

Earth terminals shall be coloured green/yellow and shall clamp to the fixing rail in order to provide earth continuity.

Terminals of different sizes and for different voltage terminations shall be partitioned.

Where un-isolated external voltages may be present, terminals shall be screened and a warning label fitted.

Terminals used in conjunction with current transformers shall have facilities for shorting out of the output to enable removal of instrumentation.

In any terminal arrangement adequate space shall be provided for the neat and logical termination of the incoming wiring. Terminal rails shall have provision for the installation of at least 10% additional terminals.

Terminals within cubicles and enclosures shall not be obscured and shall be easily accessed for installation and testing purposes, without removal of equipment.

1.2.8.7. Anti Condensation Heaters/ Panel Internal Illumination:

Each vertical section of MV switchgear shall incorporate wiring for supplies to anti condensation heaters. The wires will be energized from a single phase supply

obtained from a separate distribution board. The heater circuit shall be controlled by a rotary type ON/ OFF switch, HRC fuse or MCB mounted inside the panel and adjustable type thermostat. Multitier cubicles shall have cubicle heater and thermostat for reach vertical panel section.

The heaters shall be located in cable alleys where such alleys are available or shall be located in the bottom portion.

Panels / panel sections shall be provided with fluorescent lamp lighting fixtures of 20W rating protected by HRC fuse and a switch or a MCB located inside the panel.

1.2.8.8. Safety Arrangements:

All terminals, connections, relays and other components which may be “Live” when front access doors are open shall be adequately screened / shrouded.

1.2.8.9. Auxiliary Switches:

Auxiliary switches/ devices shall be supplied as required for indication, protection, metering, controls, interlocking and supervisory purposes. They shall be readily accessible and enclosed in transparent dust proof cover.

1.2.8.10. Panel Internal Wiring:

Inside switchgears, motor control centres, annunciation panels, etc the wiring for control, signaling, protection and instruments shall be done with PVC insulated copper conductors of minimum 1.5 sq. mm size. Wiring for CT circuits shall be with 2.5 sq.mm copper conductor. The insulation grade for these control wires shall be 1100 V. Inter panel wiring shall be enclosed in PVC wire ducts. Wiring for three phase circuits shall be colour coded red, yellow and blue for identification of relevant phases. For single phase AC circuits white coloured wires shall be used for phase conductor and black coloured for neutral conductor. Grey coloured wires shall be used for DC circuits and green coloured wires for earth connections. Circuits in which the operating voltage exceeds 110V shall be physically segregated from all other wiring. All wiring shall be neatly and securely fixed by insulated cleats or run in insulated wiring troughs. Wiring shall be so arranged that access to any apparatus or connection point is not impeded. Wiring carrying low-level DC signals shall be segregated from AC circuits and screened if

recommended by the manufacture of associated equipment/ instruments. Spare contacts available on relays / devices etc shall be wired up to terminal blocks. Wires shall be joined or tied between terminal points.

Each wire shall be identified at both ends by yellow colour PVC ferrules marked with black letters/ numbers. The letters/ numbers used for marking on ferrules shall correspond with the appropriate wiring diagram. Trip circuit wires shall be distinguished by an additional red colour. Ferrules of other colours, if used, shall be subject to the Employer approval.

Wiring termination shall be made with solder less crimping type tinned copper lugs. Insulated sleeves shall be provided at all termination.

1.2.9 Main and Auxiliary Bus Bars:

Bus bars shall be of uniform cross section throughout the length and made of high conductivity hard drawn conforming to IS 613.

1.2.9.1. Safety

Access to any enclosure shall be possible only when the circuit isolator is open and unless connections within the enclosure are isolated or fully shrouded against accidental contact.

Where a test facility exists for use with the enclosure door open all live contacts shall be shrouded to prevent accidental contact.

Isolators shall be pad lockable in the 'OFF' position. It shall not be possible to open the assembly door when the isolator is in the 'ON' position.

1.2.9.2. Short Circuit

The short circuit rating of the assemblies shall be suitable for the point of installation in the system. Where possible short circuit protective devices shall be coordinated to ensure that a fault in any outgoing branch does not operate the assembly incoming protection device.

1.2.9.3. Earthing

Assemblies shall be provided with earthing facilities as follows.

For small single compartment assemblies an earth stud shall be provided.

For large single compartment or multi-compartment assemblies a clearly marked continuous Alum./ GI earth bar of minimum 40mm x 5mm shall run the entire length of the assembly and shall be provided with terminals for connections to the metal cladding or armouring of all incoming and outgoing cables. The earth bus size shall be generally 10% of phase size subjected to meeting short circuit conditions and minimum size for any panel shall be 40x5mm.

The temperature rise of the busbar and connections under fault conditions shall not cause damage to the connections of any equipment to which they may be connected. The earth fault calculations shall be submitted along with detailed engineering.

No earth terminal bolts or studs shall be less than 8mm diameter.

An earth bond of minimum size 4 sq.mm. shall be made to all enclosure doors.

1.2.9.4. Labels

The assembly as a whole and each compartment shall be clearly and unambiguously identified.

The labels shall be engraved letters and numbers filled black on a white background.

Warning labels shall be engraved and filled black on a yellow background.

Labels shall be affixed with non-corrodible rivets or screws.

Internal labels shall be used to identify all components and terminal strips. They shall be of plastic in constructions and shall be affixed adjacent to the component to which they appertain.

1.2.10 Internal Wiring Arrangement:

1.2.10.1. Internal Power Distribution

The internal power distribution arrangement for each assembly shall comprise an MCB distribution board arrangement for each voltage present. Separate switches on this board shall be dedicated to individual circuits in order to ease fault finding and

to localize faults.

Separate MCB's shall typically be provided for supplies to :

For 240 V AC : Power supplies
: CPU and input modules
: PLC output modules
: Transformers
: Rectifiers
: Each instrumentation loop
: Panel Lighting
: Panel cooling
: Anti-condensation heating
: Internal socket outlets

For 24V DC : DDC input/ Output circuit and modules

Where specified auxiliary contacts shall be fitted to each MCB to indicate a trip.

The power supply for PLC & PC to be tapped from true Online UPS providing immunity from mains voltage disturbances.

The 24V DC power shall be derived from a regulated reliable voltage power supply.

1.2.10.2. Arrangement of Internal Components

Internal components shall be laid out in a logical manner in order to provide freedom of access to terminations and to allow removal of any component without interference to adjacent components.

Particular attention shall be paid to the location of heat dissipating equipment such as power supplies etc. in order that they do not have a detrimental effect on adjacent cabling or components.

Where necessary forced ventilation shall be provided by extraction fans mounted in the sides or access doors of the assembly as appropriate. Unless otherwise specified disposable filters shall be provided at the inlet grills. These shall be

externally serviceable without affecting the operation of the assembly.
An over-temperature alarm signal shall be provided by the volt free contacts.

1.2.10.3. Terminal Arrangements

Cable entering and leaving an assembly shall do so via suitably positioned terminals.

Terminals shall be arranged in function groups as follows:

- Supply outputs to field devices
- Signal inputs from field devices
- Control output to starter section
- Signal inputs from starter sections
- Signal inputs to telemetry
- Signal outputs form telemetry

Within each group terminal shall be arranged in subgroups as follows:

- Voltage
- Energized with panel door open
- De-energized with panel door open
- Digital signal
- Analogue signal

Terminals for circuits at voltages greater than 24V that are not de-energized when the assembly door is open shall be screened and labeled accordingly. Wiring for different voltage like A.C. And D.C. shall be carried out by different colour and in case any components/voltage is live even if incomer of the panel is off then it should be labeled along with warning sign and orange colour wire should be used for this type of wiring.

Incoming and outgoing cables to intrinsically safe barriers shall connect to the barriers via knife terminals.

1.2.10.4 Lighting:

Each cubicle of an assembly shall be provided with an internal switched fluorescent luminaire. It shall be positioned to illuminate all internal areas of the assembly

cubicle.

1.2.11 Motor Control Gear and Control Panel Assembly Control Facilities

Unless otherwise specified assemblies shall contain dedicated sections for motor drive, starters, common control, instrumentation, lamp test.

1.2.11.1 Motor Drive Starters

All starter modules shall be self-contained. The drives shall have manual and automatic control features selectable by manually positioning a starter mounted automatic/ off/ manual selector switch.

Facilities may also be provided for manual control to be carried out locally or remotely. If this facility is provided a remote/ local selector switch shall be provided on the starter. In this instance a remote start/ stop station is located adjacent to the drive. This station is only active when the starter is selected 'manual' and 'remote'.

Control in manual mode shall comprise safety controls only.

Control in automatic mode shall comprise safety controls and process controls.

a. Safety controls shall comprise controls necessary for the safe operation and protection of the drive in order to protect the drive itself and/ or personnel. Typically these shall comprise flow check switches, run dry protection, overrun devices, torque switches, overload, over temperature, high pressure, emergency stop devices etc. These devices shall be hard wired direct to the starter and shall be independent of any PLC/ DDC controls that may exist.

b. Process controls typically interact with the drive via a PLC/ DDC or hard wired logic. Typically these shall comprise controls for duty rotation, auto standby, level and flow control, sequencing, start up/ shut down procedures, scheduling etc.

Section of manual control shall enable local drive start/ stop controls at the starter itself or remote manual controls if fitted. In this mode the starter shall operate independent of process controls. All safety controls shall be operative.

Selection of automatic control shall deactivate local and remote manual controls. In this mode the starter shall respond to the dictates of process and safety controls.

For starters module of motors rated for 100 H.P. and above, they shall have (besides above protection) numeric type microprocessor relay along with temperature scanner for windings. There should be minimum two thermocouples /PT 100 devices for each winding. These should be wired from motor to starter.

1.2.11.2 Common Control Section

This section shall house:

Safety controls which are related to drive groups rather than specific drives. Typically these shall comprise run dry protection (when used in a common sump), group emergency stop control, etc.

Process controls facilities. These facilities shall typically be provided by a PLC. However, unless otherwise specified, hard wired logic will be acceptable for simple control schemes comprising less than twenty control relays.

Lightning protection barriers, if fitted, shall be installed at the base of the section adequately segregated from all other unrelated devices.

The common controls section may also provide facilities for the marshalling of starter module status, alarm and remote control signals in order to facilitate the use of multi core cable connections to remote locations.

The interior of the common control section shall be accessible without isolation of any drive or circuit. Therefore all voltages in excess of 24V shall be screened to prevent access.

Each circuit shall be individually protected by an MCB such that maintenance work can be carried out with the minimum of interference to running pumping station.

The front face of the common control section shall typically be fitted with pumping station controls, status indication and alarm annunciation facilities.

Alarm annunciation facilities shall show drive group faults, non-drive related faults and drive common fault alarms, Specific drive related faults shall be indicated at the drive module itself i.e. the common controls fault annunciator may indicate a

fault on drive A but starter module A shall indicate precisely what the fault is.

1.2.11.3 Instrumentation

This section shall house equipment associated with field and panel mounted instrumentation. Lighting protection barriers, if fitted, shall be installed at the base of the section adequately, segregated from all other unrelated devices.

Each circuit shall be protected by an MCB such that maintenance work can be carried out with the minimum of interference to running pumping station.

1.2.11.4 Lamp Test

Facilities shall be provided to test all lamps on an assembly. This shall comprise a common lamp test section. Operation of the lamp test circuit shall energize a relay in each section of the assembly in order to light each lamp and annunciator. The lamp test circuit shall pass through auxiliary contacts on section isolators if fitted. A short time delay shall ensure that the lamp test supply is retained to allow visual checking of all lamps.

On small assemblies, less than ten starters, individual lamp test buttons on each section shall be acceptable unless otherwise specified.

1.2.11.5 Emergency Stop Circuitry

Each drive or group of drives shall provide with an emergency stop facility which shall comprise a red coloured, mushroom headed, stay-put-twist to release push button. The emergency stop device shall be located adjacent to the drive or drive group to which it relates and shall be clearly labeled. Individual drive emergency stop devices shall be wired directly into the drive starter contactor circuit.

1.2.11.6 Local Control Station

These shall be of heavy duty construction and with the smaller sizes designed for mounting on or near the pumping station to be controlled. The bottom face shall be arranged to accept with adequate space for the use of spanners, gland terminations for the number of cables required. Cables shall enter from the top generally. Terminals provided for interconnections shall be easily accessible and marked with identification numbers/ letters corresponding with the associated diagrams. Indicator lamps shall be not less than 20mm diameter and have projecting

lenses with a wide angle of vision.

Pushbuttons and selector switches shall be of heavy duty, oil tight type of matching design. Legend plates shall be provided to identify equipment to be controlled and the purpose of each operating or indicating device. Pendant type control for cranes, hoists, etc. shall be of molded neoprene or equivalent heavy flexible, high impact strength materials, with a long molded-in cable strengthening sleeve, to minimize the possibility of cable fracture at the bending point. The enclosure shall be colored in safety yellow.

1.2.12 HV Switchgear Components:

1.2.12.1. Circuit Breakers:

Circuit breakers shall be vacuum / SF 6 type and of the drawout pattern. SF 6 circuit breakers shall be puffer type or self extinguishing type with rotating arc of dead tank and single pressure design. SF 6 pressure/ destiny monitoring switch/ contacts shall be provided. The short circuit fault level of HT Panel shall be obtained from nearest power distribution agency grid station and shall be taken as minimum 350 MVA. Vacuum breakers shall have completely sealed interrupting units for interruption of arc inside the vacuum. All breakers shall be provided with contact wear guage and we should be able to measure snatch gap below the interruptible vacuum bottle. It shall be possible to isolate easily the vacuum interrupted unit from the breaker operating mechanism for testing of the interrupter. Circuit breakers shall be complete with surge arrestors (if the breaker design necessities the same) to provide protection to the equipment controlled by the breaker, against switching surges. However for motor starting application surge suppressors shall be provided. Circuit breakers shall be fully rated for the specified ambient conditions.

1.2.12.2 Operating Mechanism for Circuit breakers:

The circuit breakers shall be operated by a motor operator spring charging type mechanism. The motor operated spring charges mechanism shall be completed with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit. The tripping spring shall be charged by the closing action to enable quick tripping. Closing of the circuit breaker shall automatically initiate

recharging of the spring to enable the mechanism to be ready for the next closing stroke. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. The charging mechanism shall be provided with mechanical indicators to show 'charged' and 'discharged' conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker. The operating mechanism shall be designed to release the spring to close the circuit breaker only by a deliberate action. Only one closing operation of the circuit breaker mechanism shall result from each closing impulse (manual / electrical), even though the breaker trips while the control device (manual / electrical) is being held in the 'close' position. The circuit breaker mechanism shall make one complete closing operation, once the control switch has been operated and the first device in the control circuit has responded, even though the control switch is released before the closing operation is complete, subject to the condition that there is no counter-impulse for tripping. Spring of motor operated spring charged mechanisms should not discharge until they are fully charged, and the charging means are disconnected. All switch gear compartment like circuit breaker compartment busbar chamber, CT & cable box compartment should be provided with pressure relief flap. Metallic safety shutters should be provided for busbar spouts and circuit spouts be interlinked with movement of circuit breakers. All operating mechanisms shall be provided with ON/OFF mechanical indicators. A local manual trip device shall be provided on the operating indicators.

1.2.12.3. Isolators & earth switches:

Unless otherwise specified isolators and earth switches shall be off-load and fixed type. For vertical isolation type switch gear integral earthing facility for busbar side (for incomer breaker) or circuit side (for outgoing breaker) shall be provided by breaker transfer position principle. For horizontal isolation type switch gear earthing should be provided by integral earthing switch or earthing truck for busbar and circuit side. Mechanical and electrical interlocks shall be provided where applicable to ensure that the isolators cannot be operated unless the associated breakers are open.

1.2.12.4. Circuit Earthing Facility:

It shall be possible to connect each circuit of the switchgear to earth, either through earthing switches or through trunk mounted earthing devices.

Earthing switches shall be mechanically interlocked with the associated breaker/isolator to prevent earthing of live circuit. Necessary NO and NC auxiliary contacts shall be provided on each earth switch for interlocking with the respective circuit breaker.

1.2.12.5. Relays:

All relays shall be numeric type microprocessor type. Relays shall be equipped with operation indicator LED's for visual indication. On three phase relays with separate phase elements, each phase element shall have separate indicator with phase identification clearly marked. Output elements of over current, earth fault & other relays shall operate through master tripping electro-mechanical relay.

All relays shall be suitable for flush mounting, with only the dust tight covers projecting from the front of the panel. All relays shall be accessible for setting and resetting from the front. Access to setting devices shall be possible only after the front covers of the relays are removed. Resetting facilities shall however be accessible external to the relay case.

All protective relays except auxiliary relays shall be of the drawout type. Where it is not possible to provide protective relays of the drawout pattern due to non manufacturing range, fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays. All relays shall be provided with positive action flag indicators visible from the front. No control relay except under voltage relays, which would trip a circuit breaker when de-energized, shall be used. Auxiliary relays shall be rated to operate satisfactorily between 80% and 110% of the rated voltage. Tripping relays shall be rated to operate satisfactorily between 50% and 110% of the rated voltage. The successful bidder shall prepare coordination chart of all relays with the help of graphic chart and shall submit it for approval. The successful bidder has to ensure that only immediate relay trips first.

1.2.12.6. Current Transformers (CTs)

All current transformers shall have a short time current rating of not less than that of the switchgear in which they are incorporated. CTs shall be resin cast type and shall have class 1.0. Rating of CT's shall be worked out in such a way that 30% spare VA capacity is available.

Duplicate rating labels shall be fitted on the exterior of the mounting chambers suitably located to enable reading without the removal of cover or metal sheeting forming part of the structure of the switchboards.

1.2.12.7. Voltage Transformers (VTs):

Voltage transformers shall be supplied where required. They shall have a winding ratio to give voltage between lines of 110V on the secondary. They shall have a rated burden, at the stated accuracy, in accordance with the requirements of all connected instruments, meters and relays and of any instruments or meter to which they may be connected via test blocks.

The primary circuit shall be protected by HRC fuses having a short circuit rating of not less than that of the Switchgear. The connection between the fuses and the switchgear primary conductors shall be capable of withstanding the short time current of the switchgear.

The secondary circuit shall be protected by HRC fuses mounted as closely as possible to the secondary terminals. The fuses shall have safe access for replacement without the necessity for complete isolation of the switchgear.

Windings for metering circuit shall have accuracy class 1.0 and those for protective circuits shall have accuracy class 5 P10.

VT shall have continuous over voltage factor of 1.2 and short time over voltage factor 1.5 for 30 seconds for effectively earthed system and in case of resistively earthed system or non- effectively earthed system, the short time over voltage factor shall be 1.9 for 30 secs.

1.2.13. Switch Tripping Unit (Batteries, Battery Chargers and DC Distribution Boards)

1.2.13.1. General

Switch tripping unit shall comprise battery, charger and DC distribution board housed in a common sheet steel enclosure. The enclosure shall be of cold rolled cold annealed (CRCA) and thickness shall not be less than 2mm. Enclosure shall be of indoor, floor standing, totally enclosed, dust, damp and vermin proof of adequate strength and rigidity. Degree of protection shall be IP-42. The equipment shall be so housed in the cabinet as to facilitate easy inspection and maintenance. To prevent accident all live parts inside the cabinet shall as far as possible be adequately insulated to avoid contact during maintenance. All external fasteners shall be cadmium plated/ zinc passivated to withstand the atmosphere conditions. The cabinet shall be complete with all necessary wiring, cable glands and sockets for incoming and outgoing circuits and suitable circuit label/inscriptions made of non-rusting metal, 3 ply lamicaid or engraved PVC. Two earthing terminals shall be provided to earth the cabinet. All the steel works of the cabinet shall be painted after suitable pretreatment with anti-rust paint and special finishing paint. The internal surface shall be painted in white and the external surface in dark admiralty gray colour.

1.2.13.2. Battery

Batteries shall be of high performance 30V DC lead acid SMF conforming to relevant IS. The battery calculations shall be attached with the bid. Batteries shall be suitably sized to supply the control requirements of HT and LT breakers and Annunciators wherever required. Batteries shall have cells housed in translucent, high impact plastic containers. The containers shall be fitted with vented filler pumps. High and low electrolyte levels shall be permanently marked on the container. Cell terminals shall be of bolted type. The terminal polarity shall be permanently marked. Battery cells shall be arranged so that each is accessible for test and inspection. Cells shall be arranged in single steps, double tier rack formation and shall be not less than 300mm above floor level. Batteries shall be supplied complete with all necessary connections. The connections between tiers and cells and disconnection links and fuses shall be of the multi-stranded plastic insulated type. The battery rack shall be made of mild steel painted with alkali

resistant paints and shall be supplied in knocked down condition which could be bolted and assembled at site. The batteries shall rest on treated wooden planks inside battery racks.

1.2.13.3. Battery Charger

Battery Charger shall conform to relevant and IS code. The charger shall be a float cum boost charger suitable for rating lead acid cells upto 1.85V per cell and also capable of quick charging the battery upto 2.2V / cell. The charger should be able to supply continuous DC load during boost charging with 10% margin.

1.2.13.4. Terminal Arrangement

The Battery and Battery Charger shall have terminals suitable for connecting PVC insulated, armoured aluminum cables. Approved type of terminal lugs and screwed type glands for the entry of cables in the panels shall be provided.

1.2.13.5. Accessories

Each battery shall be complete with all accessories and devices including but not limited to the following:

- i. Battery stands
- ii. Set of inter-cell, inter-row and inter-bank connectors and number plates as required for
the complete installation.

One number each of the following accessories shall be supplied with each battery unit.

- i. I-centre zero cell testing voltmeter to IS: 1248 scaled 3-0-3 volts/
- ii. Plastic filling bottle
- iii. Insulated box spanner
- iv. Insulated tommy bar
- v. End lugs
- vi. Bellavee washers
- vii. Lugged inter row cable
- viii. Vent caps

Battery Charger and DCDB shall be provided with the following Components.

- I. Double pole rotary switch for AC input
- II. HRC fuses with fittings for the above
- III. Pilot lamp to indicate the equipment ON condition
- IV. Variance to give step less control of DC output voltage from 0-48V.
- V. Double wound, impregnated, naturally air cooled single phase mains transformer
with taps.
- VI. Single phase, full wave bridge connected, silicon controlled rectifiers.
Stack with RC net
work for each SCR for surge suppression.
- VII. Filter circuit to reduce the ripple content to 3% RMS
- VIII. Moving coil ammeter of suitable range and size to measure the DC output current
- IX. Moving coil voltmeter of suitable range and size to measure the DC output voltage.
- X. HRC fuses with fittings for DC output
- XI. Voltage dropping diode with selector switch and contactor
- XII. Cable connection from battery to charger
- XIII. Cubicle internal light operated from a 240V, single phase, AC system with on-off switch.
- XIV. Battery earth leakage relay comprising of solid state sensing/triggering circuit with
electromagnetic relay with center zero millimeter isolating switch and fuse.
- XV. Space heater suitable for operation on 240V, 1 phase, 50 hz, A.C system with ON-OFF
switch.
- XVI. Local auto/visual annunciations for the following faulty conditions shall be provided for:
 - a. Mains fuse failure
 - b. Rectifier fuse failure

- c. Capacitor fuse failure
- d. D.C output overload
- e. Rectifier control supply failure

1.2.13.6. DC Power Supply:

The Power supplies will operate from 240V AC, and produce a 24V and 48V DC output voltage at full load current

Voltage regulation : 0.02% for $\pm 10\%$ mains voltage variation

Load regulation : 0.3% from zero to full load conditions

Triple at full load : <1 mV rms

The power supply shall incorporate an over voltage protection circuit, the components of which shall be independent of the voltage regulating circuit.

The protection circuit shall operate within 50ms of an over voltage occurring and shall cause rupturing of the mains input or output fuses.

Automatic reset of the over voltage protection circuit is not permitted.

1.2.14. Harmonic Filter

Harmonics generated in electrical systems shall be limited to directives of IEEE519. If harmonics are exceeding than limits specified in IEEE519; necessary harmonic filters (Active or Passive) shall be provide to control them within specified limit.

1.2.15 Motors

The bidder shall strictly adhere to following condition while selection of motor:

- i. Motors of 3000 rpm are not acceptable. In turn the bidder shall not consider pumps/ drives of 3000 rpm/ 2900 rpm. 2 pole motor shall not be considered anywhere in the project.
- ii. Bidder shall take in general 15% additional safety factor while selecting the motor's KW. Bidder while selecting motor size shall take 25% safety margin for

motors upto 5 KW and 15% safety margin for motors rated above 5 KW. Safety margin is defined as safety on top of EKW required by pump plus efficiency of motor.

- iii. All the motor shall be provided with class F insulation and with temperature rise limit of B class above ambient temperature when operating at full load.
- iv. All the motors shall have overloading capacity as per latest revision of IS.
- v. The noise level during the operation of the pump sets/ drive shall not exceed 85 dBA at a distance of 1.86 m from the pump/drive.
- vi. The mechanical vibration limits shall be as required by BS 4675: Part 1 to class III, subclass B or better. Vibration measurements on the drive and non drive end of motor bearing, pump bearing housing and base plates shall not exceed 2.8 mm/sec. RMS within $\pm 10\%$ rated head, while the limit is 4.5 mm/sec RMS for balanced portion from shut off to maximum flow. The above indicated vibrations shall be measured at the manufacturer's works during testing. For the purpose of guarantees the site tests shall govern.
- vii. All motor shall be on LT system. However, the motors above 75 KW shall be of slip ring type.

1.2.16. Lighting Fixtures:

1.2.16.1. Luminaries

- a. Luminaries shall be designed for continuous trouble-free operation without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fitting shall be weather-proof and rain proof type conforming to minimum IP-54 protection.
- b. The luminaries shall be designed so as to facilitate easy maintenance. Including cleaning, replacement of lamps/ starters etc.
- c. Connections between different components shall be made in such a way that

they will not work loose by small vibration.

- d. All luminaries shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage and frequency indicated in the Employer's Requirement.
- e. Fluorescent type, metal halide and sodium vapour type luminaries shall be complete with accessories like lamps, ballasts, power factor improvement capacitors, starters, re-wireable fuse and fuse base. These shall be mounted as far as possible in the luminaire housing only. If these cannot be accommodated integral with the Luminaires then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop-out connections. Outdoor type fixtures shall be provided with outdoor type weather-proof box. No mercury vapour lamps shall be used indoor & outdoor. Mainly sodium vapour lamps shall be used outdoor.
- f. Fluorescent type Luminaires with single or double lamp shall be provided with electronic ballasts and these luminaire shall be used upto maximum height of five meters..
- g. Each luminaire shall have a terminal block suitable for loop-in loop-out and T-off connection by 250/ 400V, 1 core, PVC insulated copper/ aluminum conductor wires up to 4 sq.mm. in size. In outdoor areas the termination at the luminaire shall be suitable for 1100V, PVC insulated, copper/ aluminum conductor, armoured cables of sizes upto 6 sq.mm. alum. conductor or suitably sizes cable as per design. Terminals shall be of stud or clamp type. The internal wiring shall be by means of insulated copper wire of minimum 1.5 sq.mm. size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.
- h. Mounted facility and conduit knock-outs for the luminaries shall be provided.
- i. Earthing
 - 1. Each Luminaire and control gear box shall be provided with an earthing terminal.

2. All metal or metal enclosed parts of the luminaire/ control gear box shall be bonded and

connected to the earthing terminal so as to ensure satisfactory earthing continuity

j. Painting/ Finish

- All surfaces of the luminaire control gear housing accessories shall be thoroughly cleared and

degreased. It shall be free from scale, rust, sharp, edges and burrs.

- The luminaire housing shall be stove-enameled/ epoxy stove-enameled - vitreous enameled or

anodized as indicated under various types of fittings.

1.2.16.2. Decorative Luminaire

Fluorescent Luminaires shall be provided as per following guide lines :

- a. These luminaries shall be generally indoor type provided with cold rolled cold annealed (CRCA) sheet steel channel/ rail cum reflector housing complete with all electrical control accessories mounted on it. The finish shall be stove enameled.
- b. Decorative fluorescent type luminaries shall be provided with aluminum louvers providing minimum glare at work station.
- c. Luminaires shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling/ wall/ column pendant mounting or for recess mounting in false ceiling.
- d. Decorative luminaries with mirror optic reflectors shall be of the wide angle dispersion type. Where these luminaries are mounted in control rooms and computer rooms, clip-on type adjustable reflectors which can be attached onto the tube shall be provided to direct the light output in the desired direction. This is mainly to reduce reflection of the light source from TV/ monitor screens.
- e. Luminaires mounted recessed in false ceiling shall be with reflector housing and spring loaded fixing arrangement for the diffuser/ louver frame. It shall be possible to have access to the lamp and other accessories from below.

1.2.16.3 Industrial Luminaires

Fluorescent Luminaires shall be provided as per following guidelines :

- a. The luminaire shall be provided with CRCA sheet steel mounting rail with reflector of minimum 22 SWG thickness and complete with all control accessories mounted on it. The finish shall be vitreous enameled.
- b. Luminaires shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling/ wall/ column/ pendent mounting.
- c. The distribution of light shall be such that at least 80% of the total luminous flux from the luminaire shall be in the lower hemisphere.
- d. The luminous output of the luminaire with reflector shall not be less than 75% irrespective of type of reflector used.
- E. Luminaires for use in areas where chlorine is stored or dosed shall be fully enclosed to IP-65 and have a luminaire body constructed of GRP or some other non-metallic material resistant to attack by chlorine.

1.2.16.4. Incandescent/ Metal Halide / Sodium Vapour Luminaires

1.2.16.4.1. Bulk head Luminaire

- The Luminaire shall be robust construction, with cast aluminum/ vitreous enamelled housing, heat and shock resistant prismatic or clear glass cover fixed with neoprene gaskets for sealing. For mechanical protection to the glass cover, round steel wire guard with vitreous enameled finish shall be provided.
- The Luminaire shall be suitable for incandescent lamp up to 150 watts, for direct mounting to ceiling/ walls/ column and used for general purpose indoor lighting.

1.2.16.4.2. High and Medium Bay Luminaires

High medium bay luminaires shall be with cast aluminum housing, anodized aluminum mirror polished reflector canopy with eye bolt for suspension, cooling fins and glass cover.

- The luminaire shall be suitable for metal halide up to 1000W and sodium vapour lamps up to 400 watts. The control gear accessories shall be

mounted integral with the luminaire.

- High bay luminaires shall be used when the mounting height is above 8 meters while medium bay luminaires shall be used when the mounting height is around 5 to 8 meters.

1.2.16.4.3. Flood Light Luminaries

a. General purpose flood Light Luminaries

18. Flood Light luminaries shall be of weather proof construction with cast aluminum housing, anodized aluminum mirror polished reflector, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust. The housing shall be supported on a cast iron base and capable of being swiveled in both horizontal and vertical directions and locked in any desired position. For focusing purposes, knobs, shall be provided along with sector plate indicating the angle in degrees between 0-90 degrees, in vertical direction. The Luminaries shall be suitable for single and dual metal halide or sodium vapour lamps up to 400 watts. When metal halide or sodium vapour lamp specified, the same shall be mounted in a separate sheet metal enclosed/ cast aluminum weather proof control gear box. The luminaries shall be provided with cable gland on the canopy in down ward direction for cable connection. It shall be possible to adjust the lamp position to achieve wide beam, medium beam or narrow beam. It shall be possible to replace the lamp from the canopy without opening the front glass.

b. Outdoor Lantern Luminaires Post top Lantern

- Post top lantern Luminaires shall be generally outdoor weather proof type of illumination of walkways, gate posts, gardens or in front of office area only.
- The luminaire shall have cast aluminum spigot of 50/60 diameter finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

1.2.16.4.4. Street Lighting Luminaires

a. Fluorescent Luminaries:

- Street lighting fluorescent luminaire shall be outdoor weather proof type for illumination of secondary roads, walkways, peripheral lighting of buildings etc.
- The luminaire shall be of semi-cut off or non-cut off type, CRCA sheet steel housing, vitreous enamelled, plain or corrugated clear acrylic cover, complete with integral mounted control gear, neoprene gaskets, side pipe entry or top suspension type.
- The outdoor luminaire shall have IP 55 enclosure.

b. Sodium vapour luminaries

- Street light sodium vapour luminaries shall be outdoor weather proof type for illumination of main roads, traffic islands etc.
- The Luminaire shall be of semi-cut off with cast aluminum housing, acrylic or prismatic cover, polished aluminum reflectors, complete with integral mounted control gear, neoprene gaskets and with near pipe entry.
- The luminaire shall be suitable for 1 x 150W/ 1 x 250W/ 2 x 150W / 2 x 250W sodium vapour lamp and for mounting heights up to 9 meters from natural ground level.

c. Emergency Light Luminaires

- Emergency light of installite luminaire shall be indoor type for providing emergency light during failure of normal AC supply.
- The luminaire shall be with CRCA sheet steel enclosure, complete with metallised mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/ relay, two meter length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaire.
- The luminaire shall be suitable for connection to 240V, 50 Hz single phase supply. On failure of normal A.C supply the luminaire shall pick-up automatically and on restoration of A.C supply the luminaire shall switch off automatically. The luminaire shall be suitable for incandescent lamp up to 40W or fluorescent lamp up to 20 watts.

1.2.16.4.5. Accessories for Luminaires

a. Reflector

- The reflectors shall be made of CRCA sheet/ aluminum/ silvered glass/ chromium plated sheet copper as indicated for above mentioned luminaries.
- The thickness of steel/ aluminum shall comply with relevant standards. Reflectors made of steel shall have vitreous enameled finished. Aluminum used for reflector shall be anodized/ epoxy stove enameled/ mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.
- Reflectors shall be free from scratches or blisters and shall have smooth and glossy surface.
- Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

b. Lamp/ Starter Holders

- Lamp holders shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.
- Lamp holders for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamps holder shall not be exposed during insertion or removal of lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp is in working position.
- Lamp holders for incandescent, mercury vapour and sodium vapour lamps shall be of Edison Screw (E.S.) type.
- The starter holder shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

c. Ballasts (Electronic)

- The ballasts shall be designed to have a long service life, low power loss & high power factor.
- Ballasts shall be mounted using self locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non combustible enclosures.
- Separate electronic ballast for each lamp shall be provided in case of multi lamp luminaries, except in the case of 2 x 20W luminaries.
- Electronic ballast shall have very high power factor (more than 0.95) and harmonic distortion shall be less than 10%.
- Voltage variation of ballast shall be between 140-320V.

d. Lamps

Incandescent lamp

- General Lighting Service (GLS) shall be tungsten filament incandescent type. The filament shall be coiled coil type rated for 230/250V, single phase A.C.
- Lamps shall be with Edison Screw type metal lamp caps.
- Lamps shall be milky white for diffused, soft, glare free lighting and rated up to 100 watts.

Fluorescent Lamps

- Fluorescent lamps shall be low pressure metal halide type with low wattage consumption and high efficiency and longer burning life (above 2500 hours).
- Lamps shall be of white light type suitable for operation on 240V, single phase A.C in standard lengths of 2, 4 and 5 feet and ratings up to 65 watts.
- Lamps shall be provided with features to avoid blackening of lamp ends.

High intensity discharge lamp

These lamps include high pressure metal halide lamps and high pressure sodium vapour lamps.

- High pressure metal halide lamp shall be with quartz discharge tube, internal coated shall, quick restrike time (of within 8 minutes) and with burning life (above 10000 hours) in standard ratings up to 400 watts.
- High pressure sodium vapour lamp shall be with polycrystalline translucent, coated discharge tube, coated shell, quick restrike time (of within 5 minutes) and with burning life (above 10,000 hours) in standard rating up to 400 watts.

1.2.16.5. Lighting System Equipment - Main Lighting Distribution Boards and Lighting Panels (AC & DC)

Construction Features

Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP-52. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP-55. The sheet steel used for frame shall be cold rolled of 2.0mm thick or 2.5 mm hot rolled and all frame enclosures, doors, covers along with partitions will be of same thickness.

All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets. For the main floor mounted distribution boards with the switch fuse units arranged in tier formation, the hinged door of each unit shall be interlocked so as to prevent opening of the door when the switch is ON and to prevent closing of the switch with door not fully closed. However, a device for by-passing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination/ maintenance. For wall mounting 1- phase ways lighting panels wherever provided with MCBs, arranged latched front door shall be provided with key-locking facility and slotted bakelite sheet shall be provided inside. Only the MCBs operating knobs or the fuse cap covers shall project out of the bakelite sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with TPN MCB with RCCB. Lighting panels shall be manufactured with 1.6 mm cold rolled sheet.

All accessible live connections/ metals shall be shrouded and it shall be possible to

change individual fuses, switches, MCBs from the front of the board panels without danger contact with live metal. For floor mounting type distribution boards, adequately sized mounting channel shall be supplied and for wall/ column/ structure mounting type panels suitable mounting straps shall be provided. Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/ bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

Two earthing terminals shall be provided. All sheet steel parts shall be undergo rust-proofing process which should include degrading de-scaling and a recognized phosphating process. The steel works shall be then painted with two coats of Zinc-chromate primer and two coats of final stove-enameled finish paint of specified colours.

1.2.16.6. 415V, 3 Phase Switch Socket Outlets (Receptacles):

Switch socket outlets shall be suitable for operation on 3 phase, 4 wire, 50 Hz supply system. The switches and sockets shall conform to relevant standards. These units shall be housed in epoxy painted sheet steel boxes and shall be suitable for outdoor installation. The units shall be fed from power distribution boards / switchgear etc. located in relevant areas

1.2.16.7. Receptacles (Lighting and Small Power) :

Decorative and industrial type receptacle (receptacle means a combination of a socket and a switch) units of approved make with switches shall be supplied. The units shall be suitable for mounting flush or within painted sheet steel boxes. Decorative receptacles shall be 5A / 15A rated with 5 pin sockets and 15A switches. Industrial receptacles shall be of 20A rating along with MCB.

1.2.17. Ceiling Fans & Exhaust Fans:

Ceiling fans shall be provided in areas such as offices, stores etc. Adequate ventilation arrangements shall be made for enclosed areas where ceilings fans are not proposed to be installed or cannot be provided.

Power supply for the ceiling fans shall be derived from lighting circuits. Ceiling fans shall be complete with all accessories. Regulators shall be electronic type. Heavy duty exhaust fans shall be installed in plant rooms as to achieve a 20 air changes per hour.

1.2.18. Diesel Generator:

The Scope of Work covers the design, Manufacturer; testing supply of suitable capacity D.G. set which including the following:

- a) Alternator along with its excitation system auxiliaries, circuits, control panel, metering and protection circuits.
- b) Diesel engine along with its accessories and starting system.
- c) Flexible / semi flexible couplings.
- d) Common heavy-duty channel for base frame supported by anti-vibration damper at bottom.
- e) Cooling arrangements etc.
- f) Exhaust piping with heavy-duty residential type silencer, insulation of exhaust piping and etc height of piping as per pollution control regulation.
- g) Starting lead Acid batteries with battery charger having trickle and boost charging arrangements complete with Ammeter with switch and voltmeter with fuse and switch to read battery voltage, starting motor, fuel oil, service tank, fuel oil piping etc.
- h) All control and power wiring between D.G. set, control panel batteries, safety controls, pumps and AMF panel etc.
- i) First fill of fuel oil, lubricating oil; etc including cleaning and flushing out of the system after the test at manufacture facility.
- j) Fuel and oil for testing, trials runs and up to commissioning
- k) Obtaining all licenses, approval from local authorities including but not limited to any or all of the following:
 - 1) Electric Supply Utility.
 - 2) Electrical Inspector of Govt. of Maharashtra.
 - 3) Pollution Control Board.

- 4) Fire Department of the local Fire Brigade.
- 5) Traffic Advisory Committee.
- 6) Municipal Corporation.

All requirement offered shall be provide design and reliable in operation.

Diesel Generator set capacity specified is at site condition.

The Tenderer shall specify in detail all equipment offered including auxiliaries, associated piping, cabling based on typical layout

DG set with individual Auto Transfer starting facilities is required to provide electric power to the essential loads in the events of failure of normal power supply or when normal supply is switched off under abnormal conditions like fire. When normal power fails or is tripped manually, the D.G. set should start automatically and restore electrical supply for essential loads. It should have provision to start all the equipments one by one so as to reduce higher starting current. The DG set shall also run continuously to supply power to the loads till restoration of normal power supply.

The starting time of the DG set should be as less as possible, but not exceeding 15 sec. to come on load. In case the first starting operation is not successful, two more attempts with preset time intervals should be attempts; the particular set should be locked out. When an engine speeds up and alternator develops desired voltage in frequency, generator circuit breakers will be switched on.

Both the engine and Generator shall be rated for continuous duty at full load and have an overload capacity of 10% for an hour in 12 hours operation. The excitation system shall be designed to maintain the rated voltage constant even if a load of 150% of rated load is imposed on to the Generator for duration of 15 secs. Tenderer shall indicate power consumed by auxiliaries along with the Tender document. The diesel engine shall be indoors type, multi cylinder, totally enclosed, continuous duty, direct fuel injection, series Turbo charged compression ignition, complete with its self-contained lubricating system. The lube oil system shall be provided with Engine Driven Lube Oil Pump only.

The Contractor shall carry out the installation of the DG sets including but not limited to the following:

Contractor

No. of correction

Executive Engineer

- a) Installation of the DG Set, testing, commissioning, alignment, mounting along with AVM pads on ready floor, foundation to be made by the Contractor and the cost shall be included in the rate for supply and installation of the D.G. set.
- b) Installation of fuel oil system complete with day tank and Lube oil system with necessary piping, valves, fittings, supports, etc.
- c) Installation of air intake system, exhaust gas system complete with residential type silencer, expansion bellows, etc. and necessary piping, valve, fitting. Supports etc.
- d) Installation of Auto Transfer Switch and any other electrical panel.
- e) The Contractor to supply and install the required 8" dia MS exhaust pipe upto the required height (as stipulated by Pollution Control Board Authorities) above the building in which the D.G. set are housed. The scope also includes providing insulation.
- f) Installation and charging of battery along with leads, battery stand, etc.

The fuel used for the DG set shall be High-speed diesel (HSD) only. The day tank shall be filled manually by operating Hand pump. In order to transfer fuel from day tank to engine has to be done through fuel transfer pump which should be engine driven only. The fuel oil day tank shall be provided with gauge glass, filling, drainage and vent connections with valves. Radiator shall be offered by the Contractor to cool the water received from the engine or any other cooling system as specified by Engineer-in-charge. Manual Electrical starting arrangements of the engine in case of power failure shall be provided. The system will consist of DC starter motor mounted on turning gear will receive power from the set of 24V DC Batteries. The generator shall also conform to 15 4722 or equivalent.

Tests

1. Equipment shall be tested to conform to the appropriate standard and the following tests shall be conducted in the presence of purchasers.
2. Functional tests, continuity tests and high voltage test on control panel to establish the performance called for in the specification.
3. Power frequency voltage test on switchgear and mechanical / electrical

operation check.

4. Routine test for alternator as per IS 4722.
5. Over speed test (1.2 times the rated speed for 2 minutes)
6. Transient response tests for sudden application and rejection of loads of 25% / 0, 50%, 75%, and 100% of rated capacity.
7. Wave form test (type test result are acceptable).
8. Please sequence test.
9. Vibration test.
10. Noise level test
11. Dimensional and alignment.

1.2.19. Samples:

Contractor shall be required to obtain the Employer approval for samples of items such as lighting fixtures of each type, ceiling fans, switch socket outlets of each type and rating, light/fan control switch of each type and rating, push buttons, conduits of various sizes, junction boxes, cable trays, wires and earthing conductor to be used for lighting system etc. before commencement of installation work.

1.3. DRAWINGS:

Following minimum data / information shall be made available on contractors drawing:

- a). Single line diagrams for AC and DC system.
 - i). All equipment with rating.
 - ii). Cable details for all circuits.
 - iii). Details of relays and major components related associated with each circuit.
 - iv). Bus bar details makes of equipment/ components.
 - v). Relevant reference drawings.
- b). General arrangement drawings (equipment, cabling, earthing, lighting, lightning protection etc.).
 - i). Dimensional layout drawing composite layout of these items.
 - ii). Plans and sections as required to show access space/ clearances etc.
 - iii). Civil foundation details, details of cutouts, openings, supporting/ mounting

details etc.

iv). Bill of material, identification of components / rooms / area etc.

1.4. INSPECTION OF EQUIPMENT:

a) All equipment shall be offered for inspection by the contractor. Inspections shall be carried out at the works of relevant manufacturers in the presence of the Employer's representative. Routine type and acceptance tests as applicable shall be carried out during inspection. Tests and test procedures detailed in relevant standards shall be adopted.

b) All measuring/ test instruments used for such tests shall be calibrated and certified by an approved independent testing authority. Supporting calibration certificates shall be provided. The Employer representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be provided by the contractor prior to carrying out every test showing the readings obtained, calculations and full of the calibration certificates referred to. On the day of testing, calibration validity shall not have expired.

c). Items of equipment/system not covered by standards shall be tested in accordance with the details and programmed agreed between the employer and contractor.

d). If during or after testing any item of equipment/systems fails to achieve its intended duty or otherwise prove defective it shall be modified or altered as necessary, retested and reinspected as required by the Employer.

e). No equipment / system is to be delivered to site without inspection having been carried out or officially waived in writing by Employer representative.

1.5. INSTALLATION WORK:

Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in the manufactures drawing or as stipulated by Employer. No equipment shall be permanently bolted down to foundation of structure until the alignment has been checked and found acceptable by Employer. Manufacturer's drawings, instructions and recommendation shall be correctly followed in handling, setting, testing and

commissioning of equipment. Contractor shall be required to obtain approval of Employer in respect of sample installations at commencement of any installation activity, these may include but be not limited to activities such as mounting of lighting fixtures/switch socket/switches/junction boxes etc., cable terminations, fixing of supports for cables/conduits etc., alignment/routes of cable/conduits/cable trays etc. More details in this regard shall be finalized with the contractor at site.

1.6. INSTRUMENTATION

1.6.1 Flow Measuring System

Flow measuring system shall consist of flow sensor/ transducers, flow computer and flow transmitter.

Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation in underground/ above ground pipeline. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided in accordance with the requirements of the flow meter manufacturer. The flow transmitter shall be suitable for field or panel mounting and shall accept an input from the flow sensor. It shall process the input signal and provide 4-20 mA dc output proportional to flow rate. The flow range shall be adjustable. A zero span adjustment facility shall be provided for flow transmitter and indicator. Flow measurement shall not be affected by physical properties of sewage viz., temperature, pressure, viscosity, density etc., within given limits. Contractor shall provide compensating electronic circuits if required. The overall accuracy of flow measuring systems shall be at least $\pm 1.0\%$ of the measured value unless otherwise stated.

1.6.1.1. Electromagnetic Flow meter

Full bore electromagnetic flow meter shall consist of flow sensors (i.e. flow tube), transmitter and remote flow indicator cum integrator. The flow meter shall have flanged connection and shall be inserted in the sludge line. The flow computer/

transmitter shall be microprocessor based and shall have diagnosis facility. Remote flow indicator cum integrator shall be provided on the control panel.

To ensure full electromagnetic compatibility the flow tube flanges and transmitter housing shall be connected earth.

1.6.1.2. Open Channel Flow Meter

Open channel flow measuring system shall consist of level transducer, flow computer and flow transmitter. The level of the fluid in the flume shall be measured by the ultrasonic level transducer. The level measured shall be used along with the physical characteristics of the flume to compute the flow rate.

The level 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. The design and application of ultrasonic level meter shall take into account the channel construction, the material size, shape, environment, process fluid or material, the presence of foam granules, size etc. The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuation, specific gravity changes and condensation. For application where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. The structure required for supporting the level sensor, platform, railings etc. shall be in the Contractor's scope.

1.6.2 Level Measuring System

1.6.2.1. Ultrasonic Level Meters

Ultrasonic level measuring devices applied for liquid level measurement shall comprise a transducer, control unit and remote indicator.

The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected to IP 65.

The design and application of 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.

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 applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection.

If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

1.6.2.2. Conductivity Level Switches

The electrodes used for conductivity level switches shall be stainless steel. Single electrode systems (one electrode per holder) shall be used (except where their use is impractical) with insulated electrodes such that only the tip of each electrode is exposed to the liquid at the operating level. Relay or control units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluids of low or variable conductivity shall be fitted with conductivity discs. Where relay or control units are not mounted in control panel, they shall be provided with surface mounting enclosures with a degree of protection to IP-54 for indoor locations or IP 65 for outdoor location.

1.6.2.3. Ultrasonic Differential Level Measuring System

The ultrasonic type differential level measuring system shall consist of ultrasonic type level sensors on upstream and downstream of screens, differential level computer / transmitter and indicator. The flow computer / transmitter shall be microprocessor based and shall have facility for programming (i.e. adjustment of set points). The ultrasonic transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected as per IP-65. It shall have ambient temperature compensation and adjustable datum setting facilities.

1.6.3. Pressure Gauges

Pressure gauges shall comply with BS 1780. Snubber shall be provided where the gauge is subjected to pressure pulsations and / or vibrations. The internal parts of pressure gauge shall be of stainless steel material. In chlorine applications the

diaphragm shall be silver or tantalum for other fluids an appropriate diaphragm material shall be used. The pressure gauges shall be provided with diaphragm seal arrangement. The minimum diameter for round pressure gauges shall be 150mm unless specified otherwise or where the gauge forms part of a standard item of equipment. The accuracy of pressure gauges shall be $\pm 1\%$ over the operating range. The zero and span of pressure gauges shall not change by more than $\pm 0.1\%$ of the span per $^{\circ}\text{C}$ changes in ambient temperature.

1.6.4. Surge Protection Devices

Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lighting strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semi conductors like Transorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self resetting to minimize the down time of the measurement loop. SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors.

The surge protection device shall be rated for surge rating of 10kA.

1.6.5. Cabinets for Field Instruments

Wall mounted cabinets shall be provided for enclosing transducer unit and associated accessories which are mounted outside the main control panel. The cabinet shall be of die-cast aluminum, field provided not less than IP-55 protection and shall be lockable. The cabinet shall have facilities for earthing. A steel plate shall be provided inside the cabinet for mounting instrument and accessories.

1.6.6. Alarm System

Alarms shall be initiated by the opening or closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions 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. Audible devices in the same room or area shall have distinguishable sounds and adjustable sound levels.

1.6.7. Matrix Type alarm Annunciators

The alarm annunciator shall be microprocessor based, modular, split type unit with alarm windows mounted on the front door and electronic modules inside the panel. The weather protection class for alarm annunciator shall be IP-54 of IS 13947, Part-I. Each alarm shall initiate a visible and audible indication of the specified condition. Unless otherwise specified, alarm indicators shall be grouped together in annunciator units each having at least 20% spare ways. Alarm indicator lamps (Cluster LED type) and shall have transparent screens engraved with legends approved by the employer's Representative. The legend area of each indication shall not exceed 40mm high and 75mm wide. When any alarm condition occurs, a condition device common to an alarm annunciator system shall sound and the appropriate indicator shall flash on and off. The flashing rate shall not be less than 2 Hz and shall not exceed 5 Hz. On pressing an accept pushbutton, the audible device shall be silenced and the flashing light shall become steady. The alarm indicator shall remain illuminated until the alarm condition ceases and a reset pushbutton has been operated. The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a further alarm condition occurs. At unmanned locations alarms operated on two or more annunciators shall require acceptance at each annunciator. Alarms shall be accepted automatically and the appropriate audible device silenced after an adjustable period of 1 to 5 minutes. An integral 'test' pushbutton shall be provided to illuminate each lamp in the appropriate group and to operate the audible device but shall not cause a spurious alarm condition on any other annunciator.

Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action. Alarm annunciator / indicator legends or labels shall be arranged with three lines of text as follows:

- Topline Location
- Middle Line Parameter
- Bottom Line Status

e.g. reservoir 1

level high & level low

1.6.8 Uninterruptible Power Supply (UPS)

The UPS shall be floor mounted; self-contained and metal clad and shall be suitable for operating on a non-linear load. It shall be front door accessible. The UPS system shall be true ON-Line. The ON LINE UPS shall be incorporating a six-pulse rectifier and pulse width modulation inverter technology with 100% microprocessor control with built in static and manual bypass switch. The UPS shall incorporate a DC under voltage trip circuit to electrically trip the UPS in order to protect the battery. The noise level of the unit shall not exceed 60dB (A) at 1m from the UPS cabinet. The output of the inverter shall be a sine wave having less than 5% THD for linear loads and less than 4% to 50% non-linear load. It shall be suitable for load power factor 0.8 lag. The unit shall have dynamic response such that a 100% step load causes an output voltage transient of less than $\pm 4\%$ with a recovery time of less than 4 ms. For three phase output units the output voltage shall not vary by more than $\pm 1\%$ for an unbalance for 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, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be

maintenance free lead acid type sealed for life.

Terminals shall be shrouded to prevent accidental contact. The battery enclosure shall be corrosion resistant and ventilated to prevent the buildup of gases. Warning notices shall be provided for wall mounting to warn of the presence of charge gases. The battery supply of 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 UPS battery shall have a backup of 120 minutes at full load and supported with inverter of suitable capacity.

1.6.9 Air Conditioning / Air Handling / Cooling and Ventilation / Exhaust:

The bidder shall design and provide AC / Air cooling / Ventilation and exhaust system as per the norms, regulations, statutory and process design requirement. The control room shall be provided with air conditioning of required capacity. All plant rooms shall be provided with push pull ventilation with air intake through a fan filter unit and exhaust with propeller fans. The design of supply air capacity should be based on 20 air changes per hour or heat load with inside temperature limited to a maximum of 5° C above ambient temperature. The equipment shall comprise of air intake louver, panel type filter, centrifugal air supply fan, GI ducting, Grills, propeller fans and their gravity louvers.

1.6.10 Testing / Inspection:

1.6.10.1. Tests on cables

Check details are in accordance with the specifications

Check for physical damage

Continuity Check, meggar test for insulation

Connections

No dark visible marks of armouring onto external surface

1.6.10.2. Tests on electrical installation

Check all closing, tripping, supervision and interlocking of control devices.

Check operation of all alarm circuits.

Check CT polarities, give primary & secondary injection.

Carry out relay calibration

1.6.10.3. Test on complete control system

On completion, the functioning of the complete system shall be tested to demonstrate its correct operation in accordance with the Specification. For control system testing, the contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Engineer when all the pumps are operating. The system shall be shown to operate correctly whatever the selection of duty and standby equipment may be.

Conditions to be tested shall include:

- Normal automatic operation.
- Normal manual operation
- Emergency manual operation

1.6.10.4. Commissioning Tests

Correct operation of controllers shall be verified by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. All logic sequences shall be verified to operate in accordance with the specifications. All defects and malfunctions disclosed by test shall be corrected immediately. New parts and materials shall be used as required and approved and tests shall be repeated. A report certifying completion of validation of each instrument system indicating calibration values, verification that the system performs as per requirements and any provisional settings made to devices shall be provided. A format for commissioning checklist to be provided for approval before performing the commissioning tests.

1.6.10.5. Final Operational Testing and Acceptance

Upon completion of instrument calibration and system validation, all systems shall be tested under process conditions. The testing shall include, but not limited to all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failures, interlocks and operational interlocks between systems and/ or mechanical equipment. Any defects or malfunctions shall be immediately corrected using approved methods and materials and the tests shall then be repeated. Upon completion of final operational testing, a report shall be submitted, indicating that the total control system provided meets all the functional requirements specified herein. This report shall be made in the format approved by the Engineer. The Engineer shall certify this report and it shall constitute final acceptance of the control system.

1.7. COMMISSIONING:

After completion of installation works the contractor shall arrange to carry out following checks/tests in the presence of Employer representative / Engineer - in - charge.

1.7.1 Tests on Transformers:

a). Mechanical Completion Checks:

- (i) Compare name plate details with the specification.
- (ii) Check for any physical damage, in particular of bushings and cleanliness of bushing.
- (iii) Check for tightness of all bolts, clamps and connecting terminals.
- (iv) Check for oil leakage and oil level.
- (v) Breather condition, check whether breathing line is free, silica gel is reactivated, oil is available at the bottom.
- (vi) Check for clearances.
- (vii) Water tightness of terminal boxes.
- (viii) Earthing of transformer tank and neutral.
- (ix) Ensure that all cooler and header valves are open

Contractor

No. of correction

Executive Engineer

(x) Check that the transformer is correctly installed with reference to its phasing.

b). Commissioning Test:

- Test oil for dielectric strength as per IS.
- Insulation resistance test of windings.
- Test the transformer for the following.
- Voltage/ turns ratio at all the taps.
- Winding resistance at all the taps.
- Short circuit impedance (at low voltage)
- Magnetic balance
- Core loss at normal tap at low voltage.
- IR and PI.
- Vector group test.
- Phase sequence test.
- Test the current transformers for following.
- Continuity test.
- Polarity test.
- Insulation resistance test.
- Magnetization characteristics.
- Rough ratio test (if bushing CTs provided prior to mounting of busbar)
- Measurement of secondary winding resistance.
- Line connection as per phasing diagram.
- Winding resistance.
- Insulation resistance of control wiring.
- Buchholz relay operation (for alarm and trip)
- OLTC control indicating and alarm circuit. (if used)
- Operation test of all protective devices (electrical and mechanical) and interlocks.
- Calibration of temperature indications (oil and winding) and temperature relays.

1.7.2 Tests of Motors:

a). Mechanical Completion Checks:

- i). Compare name plate details with the specification.
- ii). Check for tightness of all bolts, clamps and connecting terminals.
- iii). Check ground connection.
- iv). Bearing lubrication.
- v). Check clearance inside terminal box.
- vi). Megger testing of motor winding and cables.
- vii). Motor winding, control and power cables continuity checks.
- viii). Resistance of motor winding.
- ix). Check / calibration if RTDs, BTDs for bigger motors, flow switches (in case of water cooled motors) and if any other instrument mounted.

b). Commissioning Test:

- i). Controls and interlocks.
- ii). Ready test and settings.
- iii). Phase sequence and rotation.
- iv). Starting and no load currents.
- v). No load operation (observe variation, noise level, temperature of bearing and windings of motor , check speed of motor).
- vi). On load operation, starting and running currents operation (observe variations, noise level, temperature of bearing and windings of motor, check speed of motors), vibrations.
- vii). In case of closed loop arrangement for cooling the windings of motor, inlet and outlet temperature of the cooling air / water.

1.7.3 Test on Control Panels and Switchboards:

a). Mechanical Completion Checks:

- i). Check name plate details of every associated equipment according to specification.
- ii). Check for physical damage.

- lii). Check for tightness of all bolts, clamps and connecting terminals.
- iv). Check earthing.
- v). Switch developments.
- vi). Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawings. All interconnections between panels/equipment shall be similarly checked.
- vii). All the wires should be maggered to earth.

b). Commissioning Test:

- i). Checks on relays, functioning of relays, simulation of fault for testing.
- ii). Checks on motors.
- lii). Setting of relays, other alarm, tripping devices and interlocks as per scheme.
- iv). Phase angle checks, measurement of magnitude and phase angle of current transformer secondary currents and potential transformer secondary voltage.
- v). Functional checking of all power and control circuits e.g. closing, tripping, control, interlock, supervision and arm circuits including proper functioning of the components equipment. If inter locks are provided with other equipment, it shall be thoroughly tested.

1.7.4 Test of Relays:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for any physical damage.
- iii). Check internal wiring.
- iv). Megger all terminals to body.
- v). Megger AC to DC terminals.

b). Commissioning Test:

- i). Check operating characteristics over the entire range by secondary injection.
- ii). Check minimum pick up voltage.

- iii). Check operation of electrical / . Mechanical targets.
- iv). Relay settings to be checked by injecting different values of current.
- v). Setting of relays as per discrimination chart

1.7.5 Test for Meters:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for any physical damage.

b). Commissioning Checks:

- i). Check calibration.
- ii). Megger all insulated portions.
- iii). Check CT and VT connection with particular reference to their polarities for relevant meters.

1.7.6 Tests for Circuit Breakers:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for nay physical damage.
- iii). Check for tightness of all bolts, clamps and connecting terminals.
- iv). Check oil level, air pressure and leakage (wherever applicable).
- v). Check earth connection
- vi). Check cleanliness of insulators and bushings.
- vii). Check all moving parts are properly lubricated.
- viii). Check heaters provided.
- v) Check alignment of breaker trucks for free movement, check operation of shutters.

b). Commissioning Checks:

- i). Check control wiring for correctness of connections, continuity and IR values.
- ii). Manual operation of breaker.
- iii). Power closing / operating manually and electrically.
- iv). Breaker tripping and closing time.

- v). Trip free and anti pumping operation.
- vi). IR values, resistance and minimum pick up voltage.
- vii). Contact resistance.
- viii). Simultaneous closing and mechanical interlocks provided.
- ix). Check electrical and mechanical interlocks provided.
- x). Checks on spring charging motor, correct operation of limit switch and time of charging.
- xi). Checks on CTs.
- xii). All functional tests.

1.7.7 Tests for Voltage Transformers:

a). Mechanical Completion Checks:

- i). Check name plate details.
- ii). Check for nay physical damage.
- iii). Check cleanliness of insulators.
- iv). Check for tightness of all bolts, clamps and connecting terminals.
- v). Check earthing connections.

b). Commissioning Checks:

- i). Insulation resistance test.
- ii). Polarity test.
- iii). Ratio test on all cores.
- iv). Line connections are per connection diagram.
- v). Open delta test with low voltage, wherever required.
- vi). Measure core loss from LT side.

1.7.8. Tests for Current Transformers:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for any physical damage.
- iii). Check cleanliness of insulators and bushings.
- iv). Check for tightness of al bolts, clamps and connecting terminals.
- v). Check for oil level and leakage.

vi). Check connections.

b). Commissioning Checks:

- i). Megger between windings, winding terminals and body.
- ii). Polarity test.
- iii). Ratio identification checking of all ratios on all cores by primary injection of current.
- iv). Magnetisation characteristics, secondary winding resistance.
- v). Capacitance and tan delta test.
- vi). Dielectric test of oil (wherever applicable).

1.7.9 Tests for Isolators:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for any physical damage.
- iii). Check cleanliness of insulators.
- iv). Check for tightness of all bolts, clamps and connecting terminal.
- v). Insulation resistance of each pole.

b). Commissioning Checks:

- i). Manual and electric operation and interlocks.
- ii). Correctness of connections, continuity and insulation resistance values of control circuits.
- iii). Contact resistance of each pole / gap between male and female contacts.
- iv). Earth connections of structures and operating handle.
- v). Clearance in open and closed position.
- vi). Simultaneous closing of all phases.

1.7.10 Tests for Cables:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification, check internal /outer dia. of cores, cross sectional area of conductor.
- ii). Check for any physical damage.

- iii). Megger test between each core and armour/sheet.
- iv). Continuity check.
- v). Connections.

1.7.11 Test for Battery:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for any physical damage.
- iii). Dimensional check of plates (before assembly)

b). Commissioning Checks:

- i). Specific gravity test.
- ii). Cell voltage test.
- iii). Capacity test.
- iv). Initial charging cycle.

1.7.12 Tests for Battery Charger:

a). Mechanical Completion Checks:

- i). Check name plate details according to specification.
- ii). Check for any physical damage.
- iii). Check Connections.

b). Commissioning Checks:

- i). Functional check of auxiliary devices, such as alarms, indicating lamp etc.
- ii). Insulation test of all circuits.
- iii). Measurement of voltage regulation.
- iv). No load current and voltage (AC) and voltage and current both AC and DC) at different points.
- v). Voltage at tap cell (While boost charging).

1.7.13 Test for Electrical Installation:

a). Mechanical Completion Checks:

- i). Check all closing, tripping, supervision and interlock of control devices.
- ii). Check operation of all alarm circuits.

iii). Earthing:

- Measure resistance of each earth electrode by isolating the same from station grid as well as from other earth electrodes.
- Check continuity of grid conductors and wires.

b). Commissioning Checks:

i). Cable Testing.

All 3.3 kV, 6.6 KV, 11 KV cables to be high voltage tested.

ii). In addition to above, any other tests specified by manufacturer shall be carried out as per manufacturer's instruction.

iii). Measure voltage across bearing pedestal insulation and between rotor shaft and bearing.

1.7.14 Miscellaneous:

Mechanical completion checks and commissioning tests on items not covered above, shall be carried out by the contractor as per the instructions of Employer representative./ Engineer - in - charge.

1.8 DIESEL GENERATOR SET

1.8.1 GENERAL

1. It will be complete responsibility of successful agency to carry out following Work without any extra cost. If any minor Work other than the considered items in required being carried out without any extra cost, which may please be noted.
2. The successful agency will be responsible to operate the D.G. Set after testing and commissioning for the period of five year including defects liability period of two years from the date of completion of Work. The agency is to deploy one operator and one helper with required minor materials and tools round the clock and should take care of the required operation and maintenance of D.G. set during power failures in coordination with regular maintenance and repair agency or as specified by Engineer-in-charge.
3. The agency is required to provide Diesel for the D.G. Set as per the requirements. The diesel tank should be full/90% capacity at all times. No laps

on any accounts shall be tolerated. The payment of the same will be paid as per actual after producing required documents such as diesel consumption/cash memo etc.

4. The manual operation required for the D.G. Set is also included in this scope. The successful agency will have to operate the D.G. Set in coordination with the EMPLOYER's other Electrical departments and existing electrical M&R agency Maharashtra State Electricity Department supply is to be used as a standby supply during that period.
5. The agency is to bring adequate diesel required for the DG Set. They should operate the D.G. Set at least 10 minutes in a day and keep the D.G. set in full working condition at all times.
6. The D.G. Set provided is fully automatically operative condition. However, in case of any emergency, if the D.G. Set is not operating in its automatic mode, then the operator should be in a position to operate the D.G. Set in manual mode.
7. The agency should provide the manpower during the three shifts or as specified by Engineer-in-charge from time to time.
8. It will be the responsibility of the successful agency to obtain the necessary approval/sanctions from concerned authorities like Maharashtra State Electricity Department, Electrical Inspector, PWD, Pollution Control Board etc. before commissioning of the D.G. Set and same shall be submitted to Engineer-in-charge within the stipulated Contract period.
9. Successful agency will also be responsibility for carrying out comprehensive maintenance of total installation under Contract in addition to operation for a period of Five year including defect liability period of two year. This also included the replacement/ repairs of any defective parts and fuel and oil required, so as to ensure the required operation schedule.
10. In case if any breakdown/ power failure is notice due to negligence in operating the D.G. set during the emergency/during the required period, 2% of the total deposited amount against operation of D.G. set for the period of one year will be deducted as penalty for every incident.
11. Before quoting the Tenderer should inspect the present location where the D.G.

set is to be kept and also visit the site to collect the data for Work.

12. The successfully agency will have to design the scheme matching with existing system and Work will be started only after due approval to the scheme from Engineer-in- change.

1.8.2 SPECIAL REQUIREMENT

1.0 GENERAL

- 1.1 The entire electrical Work shall be carried out in accordance with specification without any extra cost. The Work shall conform to relevant Indian standard, Indian Electrical Acts and requirements of local electricity board.
- 1.2 For supervision, Contractor must depute qualified electrical engineer with sufficient experience for similar type of Work.
- 1.3 The Contractor shall employ only experience and licensed electrical / wiremen for the Work. Only licensed electrical Contractor are allowed to Work.
- 1.4 When the electrical installation is complete, the same shall be tested as per I.S. code, i.e. Regulations in front of Engineer-in-Charge and result are to be submitted in four sets.
- 1.5 The Contractor shall carry out all minor civil works connected with electrical Work. The Contractor shall repair and make good damage caused to the civil structure while carrying out the electrical works.
- 1.6 The foundation for panel board grouting of frames in wall etc is required to be carried out by the agency.

2.0 SCOPE

- 2.1 Supply, installation, testing and commissioning of D.G. set of desired rating, Auto transfer panel and power and control cabling Work and sound proof Enclosure (Acoustic canopy). DG set shall be provided for critical process requirement only i.e. to for load requirement of SBR air blowers, plant lighting & raw sewage transfer pumps.
- 2.2 The scope of Work also including the operation and maintenance of the D.G.

set for the period of two year including the defect liability period of one year. It also including and breakdown maintenance / replacement of defective parts and providing require manpower for daily operation of same round the clock or completely as per the requirement of Engineer-in-charge.

2.3 DRAWING & SPECIFICATION

Drawing and specification shall be followed and if any deviation from the same is necessary to make the Work conform to the requirement, the same shall be called to the attention of the Engineer. If any discrepancy between specification, Drawing and BOQ is noticed the same shall be informed to the Engineer-in-charge before execution of the Work and higher standard amount the three will take precedence.

3.0 SHOP DRAWINGS

3.1 The Contractor prepares detailed shop drawing and submits for the approval of the Engineer before commencing the Work. The shop drawings showing all setting out details and physical dimensions of all complements in the system like conduits and cable, routes, location if HT & LT pane's, D.G. sets AMF panels, sound proof canopy and fixing details. Works shall not be comments without the approval from the Engineer for each working drawings. The drawing should include circuit diagram of the AMF panel.

4.0 BROCHURE AND DATA

4.1 The Contractor shall submit to the Engineer four copies of all brochures, Manufacturer description data and similar literature. One copy will be returned to the Contractor after approval.

5.0 SCALE

5.1 Electrical layout plans shall be drawn to scale as established on drawings and shall indicate the size and location of all equipment and accessories herein. The Contractor shall obtain all dimensions preferably at the building and check those plans for interference with the building structure and other plans for interference with the building structure and other equipment.

6.0 APPROVAL

6.1 The engineers approval of such drawings, schedule, brochures, etc. will be an approval of general details and arrangements only and shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless he had, in writing, called the Engineer attention to such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors or commissions of any kind in the shop drawings when approved.

7.0 STORAGE

7.1 All materials and requirements shall be stored properly to the satisfaction of the Engineer so that physical handling and climatic conditions do not affect the equipment.

8.0 CUTTING & PATCHING

8.1 Cutting, patching and reading shall be kept to the minimum. Whenever this is required, advance approval of the Engineer shall be obtained before cutting and patching Work is taken up during the installation of Work. Those shall be subsequently finished properly to the satisfaction of the Engineer. Care shall be taken to prevent spreading of dust and debris and for protection of equipment and finishes.

9.0 PROTECTION

9.1 All Work equipment and material shall be protected at all times to prevent obstruction, damage or breakage. All equipment shall be covered and protected against water, dust and sand as well as chemical and/or mechanical damage. At the completion of the Work, all equipment shall be thoroughly cleaned and delivered in a perfect unblemished and working condition.

10.0 TESTING & COMMISSIONING

Testing and commissioning of complete electrical, accessories/equipment/ installations shall be carried out in the presence of Engineer-in-charge/ Maharashtra State Electricity Department officials as per the required norms/ directives at Manufacturers place and at site.

11.0 The Contractor shall furnish all labour and materials called for in this specification and accompanying drawings and shall install the system complete in

every respect. Only license approved electrical Contractor/Sub Contractor are permitted to execute the Work.

12.0 GUARANTEE

The Contractor shall furnish one-year guarantee on all equipment and appliances. This shall include guarantee against defects in workmanship or material in any part or accessory. If any higher period is implied elsewhere in this Contract, the same shall hold a Govern. If any defects are found during the guarantee period, the Contractor at no additional cost shall replace the defective part or Work.

13.0 HANDING OVER OF INSTALLATION:

13.1 The Contractor shall handover the complete installations to the Corporation in a clean, brand new and perfect working condition. Any area in which the Contractor has worked, shall be thoroughly cleaned of all debris and unwanted materials cleaned and handed over in a perfectly finished, ready to use condition.

14.0 DEVIATION & ORDERING MATERIAL

14.1 The Contractor must quote exactly as per specification bill of quantities and drawing.

14.2 The bill of quantities shall not be used as a basis for ordering materials and the Contractor shall be responsible for assessing the quantities of material to be ordered.

15.0 AS BUILT DRAWINGS

15.1 On completion of Work, the Contractor shall submit to the Engineer, a reproducible and five copies of "As Built" drawing showing:

- 1) LT Cable layout wherever required.
- 2) Single line diagram and complete electrical layout.

15.2 Contractor shall prepare operation and maintenance manual for the complete electric system under this Contract and submit the same in four sets.

16.0 MANUFACTURE TEST

The Contractor shall specifically perform all test such as routine test, type

test on all equipment in the presence of EMPLOYER & Maharashtra State Electricity Department officials. All cost incidental to such test shall be deemed to have been included in the specific items of that equipment and no extra charge will be payable.

1.8.3 GENERAL SPECIFICATION

1. INTENT OF SPECIFICATION

This specification is intended to cover the design engineering manufacturing, fabrication. Assembly, testing at Manufacturer Work/delivery properly packed for transport, transportation up to site, erection, testing and commissioning at site suitable design capacity of D.G. Set. The D.G. Set shall run with HSD oil and shall be supplied complete with all the accessories described below for safe and trouble free commercial operation, in manner accepted to EMPLOYER Ltd.

2. CODES & STANDARD

The design, manufacture, shop testing, erection and commissioning of compression ignition diesel Engines and accessories shall conform to the following particular standard and codes, with latest revisions in addition to the relevant standards and manufactures own standards.

3. SCOPE OF WORK

The scope of Work includes design, manufacture, supply, transport to project site, handing erection testing and commissioning of Diesel Engine driven Generating sets in conformity with the specification given herein and the schedule of quantities. The scope of Work covers the design, Manufacturer; testing supply of suitable capacity D.G. set which including the following:

- a) Alternator along with its excitation system auxiliaries, circuits, control panel, metering and protection circuits.
- b) Diesel engine along with its accessories and starting system.
- c) Flexible / semi flexible couplings.
- d) Common heavy-duty channel for base frame supported by anti-vibration

damper at bottom.

- e) Cooling arrangements etc.
- f) Exhaust piping with heavy-duty residential type silencer, insulation of exhaust piping and etc height of piping as per pollution control regulation.
- g) Starting lead Acid batteries with battery charger having trickle and boost charging arrangements complete with Ammeter with switch and voltmeter with fuse and switch to read battery voltage, starting motor, fuel oil, service tank, fuel oil piping etc.
- h) All control and power wiring between D.G. set, control panel batteries, safety controls, pumps and AMF panel etc.
- i) First fill of fuel oil, lubricating oil; etc including cleaning and flushing out of the system after the test at manufacture facility.
- j) Fuel and oil for testing, trials runs and up to commissioning
- k) Obtaining all licenses, approval from local authorities including but not limited to any or all of the following:
 - 1) Electric Supply Utility.
 - 2) Electrical Inspector of Govt. of Maharashtra State.
 - 3) Pollution Control Board.
 - 4) Fire Department of the local Fire Brigade.
 - 5) Traffic Advisory Committee.
 - 6) Municipal Corporation.

Installation and commissioning of the above D.G. Set is also including in the scope.

All requirement offered shall be provide design and reliable in operation. Diesel Generator set capacity specified is at site condition. Generator shall be rated for critical process requirements only. The excitation system shall be designed to maintain the rated voltage constant even if a load of 150% of rated load is imposed on the Generator for duration of 15 Sec. Tendered to indicate power consumed by auxiliaries along with quotation. The Tenderer shall specify in detail all equipment offered including auxiliaries, associated piping, cabling based on typical layout

PAINTING, PACKING AND TRANSPORT

All metal surfaces shall be thoroughly cleaned of scale, rust and grease, etc. prior to painting. Cleaned Surface shall be given two coats of primer and prepared for final painting. Final finish shall be free from all sorts of blemishes. The equipment shall be shipped to site suitably packed to prevent any damage. Each package shall have labels to show purchaser name, purchase order and equipment number, suitable lifting lugs, etc. shall be provided and lifting points shall be clearly marked on the package. Packing shall be suitable for storage at site for a minimum period.

TEST AND INSPECTION

The owner or his authorized representative may visit the works during manufacture or equipment to assess the progress of Work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection. Detailed test procedure along with the facilities available at Contractor works shall be furnished as and when called for. Owner representative shall be given minimum four-week advance notice for witnessing the final testing. The Contractor shall furnish test certificate including test records and performances curves, etc. The Contractor shall prepare and submit detailed shop drawing depicting the general arrangement of D.G. Sets, connected accessories, fuel tank, fuel oil piping, pumps, control panels, single line electrical diagrams for power and controls, exhaust piping, chimney, foundation details, etc. within 10 days of award of Work.

LOCAL REGULATION, BYELAWS, I.E.R. ETC

The D.G. Set installation will be generally governed by the following Regulations:

- i) Indian Electricity Rules (1956 and latest revisions).
- ii) Local regulations.
- iii) Pollution Control Rules (State/Union Govt. Rules)
- iv) Electrical Utility Co.
- v) Fire Brigade.
- vi) Electrical Inspector Approval.
- vii) Tariff Advisory Committee.

OPERATION & MAINTENANCE MANUALS SPARE PARTS, TOOLS ETC.

The Contractor shall furnish operation and maintenance manuals in triplicate after installation of the D.G. Set. One set of special tools required shall be supplied at the time of handing over of the set to the Corporation. The price of these special tool set is deemed to be included in the rates quoted by the Tenderer. The bid letter shall list out such tools that will be handed over to the Corporation.

OPERATION OF THE SET AFTER INSTALLATION

The Contractor shall arrange to depute, free of charge, a Senior Operator to the site of works to operate the D.G. Set for a minimum period of four weeks after successful installation and approval of the installation by the local authorities. The operator shall impart training to the owners operator/technicians in proper up-keep of the DG set.

COMPLETION DRAWING

On successful completion of the installation and before issuance of the certificate of virtual completion, the Contractor shall prepare and submit to the owner "as built completion". Drawings of the entire installation.

The completion drawings shall include:

- a) Layout of D.G. St and accessories.
- b) Exhaust piping arrangement.
- c) Fuel oil tank and piping.
- d) Electrical single line diagram, control wiring single line diagram, cable layout, panel GA drawings, etc.
- e) Location of earth pits and Earth conductor with sizes.

TESTING

1. The following test shall be conducted on each alternator and D.G. Set.

2. Factory Test

- i) Routine Tests.
- ii) High Voltage Test.

- iii) Short circuit Current Test.
- iv) Instantaneous short-circuit withstand test.
- v) Insulation resistance test.

These tests shall be conducted as per the requirements of the original test certificates shall be furnished to the EMPLOYER.

3. Site Tests

After the erection and wiring and earthing for DG set, the following tests shall be conducted:

- i) Insulation resistance of the generator.
- ii) Speed, no load voltage and full load voltage regulation.
- iii) Frequency at no load, half load and full load.

The readings shall be observed with calibrated meters. Only one meter shall be used for the tests. The reading shall properly tabulated and submitted in triplicate to the Engineer-in-charge.

4. Testing of Controls

All the safety controls and protective devices of the DG set shall be tested for correct calibration and operation. The result of the tests shall be tabulated and submitted in triplicate.

OPERATION

DG set with individual Auto Transfer starting facilities is required to provide electric power to the essential loads in the events of failure of normal power supply or when normal supply is switched off under abnormal conditions like fire. When normal power fails or is tripped manually, the D.G. set should start automatically and restore electrical supply for essential loads. It should have provision to start all the equipments one by one so as to reduce higher starting current. The DG set shall also run continuously to supply power to the loads till restoration of normal power supply. A potential free Contact (NO) closing on under voltage will be made available by means of a suitable control cable at the Auto Transfer control panel to indicate failure or absence of normal supply. The DG set shall start on receipt of this signal with an adjustable time delay of 0.5 secs, the

time shall be of self - reset type.

The starting time of each of the DG set should be as less as possible, but not exceeding 15 sec. to come on load. In case the first starting operation is not successful, two more attempts with preset time intervals should be attempts; the particular set should be locked out. When an engine speeds up and alternator develops desired voltage in frequency, generator circuit breakers will be switched on.

INSTALLATION

The Contractor shall carry out the installation of the DG sets including but not limited to the following:

- a) Installation of the DG Set, testing, commissioning, alignment, mounting along with AVM pads on ready floor, foundation to be made by the Contractor and the cost shall be included in the rate for supply and installation of the D.G. set.
- b) Installation of fuel oil system complete with day tank and Lube oil system with necessary piping, valves, fittings, supports, etc.
- c) Installation of air intake system, exhaust gas system complete with residential type silencer, expansion bellows, etc. and necessary piping, valve, fitting. Supports etc.
- d) Installation of Auto Transfer Switch and any other electrical panel.
- e) The Contractor to supply and install the required 8" dia MS exhaust pipe upto the required height (as stipulated by Pollution Control Board Authorities) above the building in which the D.G. set are housed. The scope also includes providing insulation.
- f) Installation and charging of battery along with leads, battery stand, etc.

CAPACITIES

The capacity of each of the D.G. set shall be suitable as per design of STP. Both the engine and Generator shall be rated for critical process requirements only. The excitation system shall be designed to maintain the rated voltage constant even if

a load of 150% of rated load is imposed on to the Generator for duration of 15 secs. Tenderer shall indicate power consumed by auxiliaries along with the Tender document.

DIESEL ENGINE

The engine shall be suitable for continuous operation to develop design capacity of dg set at site conditions as mentioned above. The diesel engine shall be indoors type, multi cylinder, totally enclosed, continuous duty, direct fuel injection, series Turbo charged compression ignition, complete with its self-contained lubricating system. The lube oil system shall be provided with Engine Driven Lube Oil Pump only.

Following accessories shall be supplied with the engine and the quoted rate for supply and installation of DG set shall be deemed to have included for the accessories described below:

- a) Air filter Air restriction gauge.
- b) Lube oil filter.
- c) Fuel oil filter.
- d) Coupling.
- e) Day service Tank.
- f) Fly wheel with Guard.
- g) Corrosion Resister.
- h) Scroll type fuel injection system.
- i) Residential type silencer.
- j) Electronic governor.
- k) Starter motor.
- l) Instrument panel.
- m) Laid Acid Battery.
- n) Exhaust Bellows.
- o) First fill of lube oil

DAY FUEL TANK

The fuel oil day tank shall be provided with gauge glass, filling, drainage and vent connections with valves. Fuel Transformer pump between Engine & Day tank should

by engine driven only.

LUBRICATING OIL SYSTEM

The Lubricating oil for engine lubrication shall be collected in the oil pan located at the bottom of the cylinder block. From oil pan, the lubricating oil shall be let off to a separate lube oil sump, if required. From the oil pan or from the oil sump the lubricating oil shall be drawn by engine driven lubricating oil pump through foot strainer (in the oil sump) and then Through oil filter of suitable capacity . The lube oil pump shall be of Gear type and Engine driven only and the entire assembly should be filter inside the sump. All the inter connecting oil piping together with valves, fittings, hangers, supports, etc. shall be provided by Contractor.

AIR / EXHAUST SYSTEM

Exhaust gas Driven Turbocharger shall be fitted to each bank and each turbocharger shall have its own self-contained lubricating oil system. Ai shall be normally supplied and ducted to the turbo-charger of low & high pressure one. Air from the Turbocharger compressor passes to the after cooler and then to the engine manifolds. The cooler shall be of Tabular constructed with aluminium bronze MS and cat-Iron water Boxes. An Engine Drive water ump shall cool it.The engine turbo charging system including exhaust and intake Manifolds, valve timing and arrangement of the cylinder Head shall be designed for optimum performance at High boost pressure with subsequent high specific Engine Power output.

GOVERNING SYSTEM

Electronic governing system shall be provided with the necessary sensors. The governor shall be suitable for operating without external power supply ad shall be provided with adequate speed control system.

FLYWHEEL

The Contractor shall be responsible for determining and providing the necessary flywheel effect. The flywheel shall be both statically and dynamically balanced and capable of rotating at 125% of rated speed without injury. Flywheel guards shall be furnished.

ENGINE COOLING SYSTEM

Radiator shall be offered by the Contractor to cool the water received from the engine or any other cooling system as specified by Engineer-in-charge.

ENGINE STARTING SYSTEM

Manual Electrical starting arrangements of the engine in case of power failure shall be provided. The system will consist of DC starter motor mounted on turning gear will receive power from the set of 24V DC Batteries.

FUEL OIL SYSTEM

The fuel used for the DG set shall be High-speed diesel (HSD) only. The day tank shall be filled manually by operating Hand pump. In order to transfer fuel from day tank to engine has to be done through fuel transfer pump which should be engine driven only.

ALTERNATOR

The generator shall be driven by the diesel engine as described in this specification and shall match the same in all respects. The generator shall also conform to IS 4722 or equivalent.

TESTS

1. Equipment shall be tested to conform to the appropriate standard and the following tests shall be conducted in the presence of purchasers.
2. Functional tests, continuity tests and high voltage test on control panel to establish the performance called for in the specification.
3. Power frequency voltage test on switchgear and mechanical / electrical operation check.
4. Routine test for alternator as per IS 4722.
5. Over speed test (1.2 times the rated speed for 2 minutes)
6. Transient response tests for sudden application and rejection of loads of 25% / 50%, 75%, and 100% of rated capacity.

7. Wave from test (type test result are acceptable).
8. Please sequence test.
9. Vibration test.
10. Noise level test
11. Dimensional and alignment.

DG AUTO TRANSFER SWITCH CONTROL PANEL

DG set shall be supplied with automatic transfer switch control panel. This panel shall be floor mounting, free standing, dust tight, vermin proof/ sheet metal enclosed, cubicle type. Cable entry to the ATS control panel shall be from the top or bottom (depending upon site condition) for power and control cable, outgoing cable, of auxiliary equipment and outgoing cable to power center.

1. The panel shall be free standing, fabrication from 14/16SWG CRCA sheet metal enclosed, dust and vermin proof type with a hinged door and having a degree of protection IP 52 as per IS 2147 unless otherwise specified. The panel shall be powder coated with Siemens gray color shade after completing 7-tank pre-treatment process. Curing shall be by baking. Finish shall be structural finish (70-80 microns). Power and control equipment shall be segregated inside the Panel as far as practicable. The maximum height of the operation handle / switches shall not exceed 1000 mm and the minimum height shall not be below 300 mm. All hardware shall be made corrosion resistant and bolts, nuts and washer shall be made of galvanized zinc passivated cadmium plated high quality steel. Unless otherwise specified the panel shall be suitable for bottom cable entry. Necessary glands shall be provided with panel.

All auxiliary devices for control, indication, measurement and alarm such as push buttons control/selector switches, indicating lamps, metering instruments, annunciation, etc. shall be mounted on the front door of the panel. Adequate number of potential free contact shall be provided in the control panel for any remote control, monitoring of the generator set.

2. All switches shall be load-break, heavy-duty type. All fuses shall be non-deteriorating HRC cartridge pressure filtered, link type. The Contractor shall be air

break type having A03 duty rating. Thermal overload relays shall be three elements, positive acting, ambient temperature compensated type with adjustable setting range and built in protection feature against single phasing. All control/selector switches shall be rotary back connected type having cam operated contact mechanism with knob type handle 'STOP' push buttons shall be stay put type.

3. Wiring for power, control and signaling circuits shall be done with PVC insulated copper conductors having 1100V grade insulation. Minimum size of control wires shall be 2.5 mm. "ELEMEX" type terminals shall be acceptable for wires upto 10 sq mm size and for conductors larger than 10 sq mm bolted type terminals with crimping lugs shall be provided. A minimum of 10% spare terminals shall be provided on each terminal block.

4. An adequately sized earth bus shall be provided in the panel for connection to the main earth grid. All non-current carrying metallic parts of the mounted equipment's shall be earthed. Doors and movable parts shall be earthed using flexible copper connections.

5. Engraved nameplates shall be provided for all devices mounted on the front of the panel. Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the panel.

The AMF control panel shall be provided with, but not limited to the following devices:

AUTO MAINS FAILURE CONTROL PANEL:

The AMF Panel shall have provision such that on switching over to DG supply; it shall not put all the drives into operation on load at a time. But the same shall be put into operation one by one with suitable time lag. The panel shall be Cubical type, floor mounted, dust and vermin proof control panel with hinged doors, CAM type doorknob, undrilled bottom gland plate, load manager each fitted with:

- > Suitable rating Amps 4 phase 36KA MCCB - Similar to MD's make Cat No.25606 with frame size of DPX 630, S-I, Electronic type - 2 NOS.
- > Shunt Release 220V A.C coil similar to MDs make, Cat No.26164 & frame size of

DPX-630 - 2 Nos.

- > Remote control front operated, motor operated similar to MDs make - Cat No.26144 & frame size of DPX-630 - 2 Nos.
 - > Auxiliary contacts similar to MDs make Cat No.26160 & frame size of DPX-630 - 2 Nos.
 - > Spreader lines similar to MDs make Cat No.625008 & frame size of DPX-630 - 4 Sets.
 - > Electronic control unit automatic supply inverter similar to MDs make of Cat No.26196 & frame size DPX-630 - 1 No.
 - > Automatic transfer switch fixed version supply inverter mounting phase suitable for suitable rating Amps similar to MDS make, Cat No.26509 & frame size DPX-630 - 1 No.
 - > Digital Ammeter of adequate rating with selector switch & CTs - 1 No.
 - > 0 - 500V digital voltmeter with selector switch & CTs. - 1 Set
 - > RYB indicating lamp - 2 sets.
 - > MCCB ON/OFF indicating lamp - 2 sets.
 - > 2 No. + NC Auxiliary contactor 220V ac - 2 Nos.
 - > Frequency meter.
 - > Digital hourly running meter.
 - > KW meter, Digital.
 - > KWH meter, Digital.
 - > Current transformers of suitable ratio of class 1 for metering.
 - > 3 Nos. current transformers of suitable ratio of Class-I for metering.
 - > 4 Pole ALB Microprocessor based EDO type contact operated by charging motor and incorporated with shutter Assembly, shunt release etc.
 - > Micro switch for service position, Test service, 3 indicators for DG ON/OFF/TRIP.
 - > CT for above ACB's
 - > Copper Bus Bar (TPN) of adequate rating.
- Mains supply Monitor to identify low voltage/complete failure and initiate necessary single for operation of automatic control gear.
- > 1 Set Window Annunciation's with audio visual alarm & Trips for:
 - i) High Water Temp.

- ii) Low lube Oil pressure.
- iii) Over speed stop
- iv) Set fails to start.
- > 1 No. Electronic Hooter.
- > 1 Set push button hooter accept/fault clear.
- > 1 No. Control switch (ON/OFF - for DG Manual control)
- > 1 No. Mode Selector Switch (AUTO/MANUAL/aEST/OFF)
- > 1 Set Indicating Lamps for 'Load on Set', 'Load on Mains' etc.
- > 1 No. Battery Charger consisting of:
 - i) Transformer
 - ii) Rectifier
 - iii) D.C. ammeter
 - iv) D.C. voltmeter
 - v) Charger selector switch (TRICKLE/BOOST/OFF)
 - vi) Lamp for battery charging indication.
- > 1 Set Instrument fuses.
- > 1 Set Bus bars of adequate capacity.
- > 1 No. of Automatic Transfer Switch fixed version (750 Amps).

CABLES

1. The specification covers the design, manufacture, performance, inspection at the Manufacturer's works and delivery to site of 1100V grade cables.
2. The design, manufacture of performance of the cable should confirm to the latest applicable standards of Bureau of Indian Standards.
3. All cable shall be XLPE and shall comply with the following requirements:
 - a) Annealed copper conductor, class 2 as per IS:8130 or aluminium.
 - b) Colour coding shall be provided.
 - c) Inner sheath shall be extruded type and shall be compatible with the insulation for the cables. The inner sheath shall be with PVC compound type 'A'.
 - d) Armouring for all the cables shall comprise G.I. strips/wires.
 - e) The outer sheath shall be of an extruded layer of type ST-1 compatible with the specified ambient and operating temperature of the cables. The sheath shall be

resistant to water, ultra violet radiation, fungus, termite and rodent attacks.
The outer sheath shall be of black colour.

- f) Cables shall be subjected to routine and acceptance tests in accordance with 15:1554 and other relevant standards.

4. General Conditions

- a) The quantities given in the schedule are subject to change to suit site conditions.
b) The Manufacturer should have in house testing facilities as per IS.

5. Specifications for Installing LT cables and Control Cables

The method of installing cable shall be broadly classified into four main categories:

Laid in prepared trenches/Hume pipes

All cables laid inside the substation building shall be laid in prepared trenches. For easy identification all cables laid shall have cable marker tied to it by means of steel wire and showing the size and name of panels embossed on it.

Laid Underground

The procedure stated in technical specification shall be followed. However, before laying all precautionary procedure shall be adopted by the Contractor. Layer of sand then cables and then layer of sand again with half round RCC pipe shall be laid.

Fixed on walls etc.

If cables are to be fixed on walls, etc. then the same shall be done by using MS galvanized spacers and GI saddles using screws, etc.

Laid on cable trays

Generally cables laid on trays shall be fixed on the rungs of the trays using nylon lockable cable ties of approved make. As far as possible, cables shall not cross each other unnecessarily on tray, so that a neat and easily identifiable cable system is achieved.

INSPECTION

All cables shall be inspected by the Contractor upon receipt at site and checked for any damage during transit.

JOINT IN CABLE

The Contractor shall take care to see all the cables received at site are apportioned to various location in such a manner as to ensure maximum utilization and avoidance of jointing cables. The apportioning shall be got approved by the owner before the cables are cut to length. Straight joints are prohibited unless specifically allowed in the schedule of quantities.

EXCAVATION AND BACKFILL

All excavation and backfill including timbering, shoring and pumping required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Backfill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed and consolidated before laying the next layer. The Contractor shall restore all surface, roadways, sidewalks, curbs walls or other works by excavation to their original condition, satisfactory to the EMPLOYER. Back filling shall be done with soft earth only.

TERMINATION OF CABLES & JOINTS

- a) For termination of cables of size 16 sq.mm. and above, suitable copper cable sockets of appropriate size and capacity shall be provided at terminal ends. This condition is applicable to single PVC insulated wires of 16 sq. mm. and above also.
- b) Generally reducer/spade type sockets shall be used where grub screw/clamp type fixing arrangement is available at the terminating end. Tubular sockets shall be used where bolt and nut arrangement is available at terminating end.
- c) The cable socket shall generally be fixed to the cable cores by crimping process.
- d) Irrespective of the size of the cable and the method of termination, the core

end shall be cleaned and immediately covered with an oxide inhibiting/corrosion inhibiting compound before termination.

- e) The tail end wire shall be finished in an appropriate colour by using PVC insulating tape.

1.8.4 TESTING, MANUFACTURER TESTS, PRE-COMMISSIONING TESTS AND COMPLETE COMMISSIONING

The general intent of this specification is to mention the relevant tests to be done and furnished to the client by the Contractor. These are guidelines. However, the Contractor shall carry out all such tests and complete all formalities as per relevant Indian Standard Specifications, Tariff Advisory Committee's rules and fire Insurance Requirements and or Electricity Rules and Regulations as per Govt. Gazette and Publications.

Testing of Equipment

All equipment before installing on the site Work shall be tested and at such results produced to the Engineer in charge nothing shall absolve the Contractor from re-performing any tests that the Contractor may be called upon specifically by the consultant/EMPLOYER or supply company or electrical inspector. All equipment shall be tested jointly with the Consultants/EMPLOYER as required by various sections of the specifications and test data shall be furnished as required at Manufacturers Work before dispatch of material at site.

Pre Commissioning Test

All rules, regulations and requirements of Maharashtra State Electricity Department, Govt. and local authorities and of Indian Standard specifications and/or Rules and regulations stated in Indian Electricity Act shall be strictly complied. On completion of erection the Contractor shall clean all the equipment thoroughly and inspect the entire installation for correctness and shall furnish a report of completion to the consultants, pre-commissioning tests shall commence only on approval of this report by the consultants. All tests and the certification thereof shall only be carried out by those authorized. Skilled, experienced and

certified permit holders of the supervisor category of state government Industries and Labour Department. No unauthorized personnel shall ever carry out any such tests as stated herein under.

- 1) Phantom load tests for protective relays.
- 2) Insulation tests at the following points by 1000 Volts and or 500 Volts megger.
- 3) Mechanical operation tests for all movable parts of switchgears breakers tripping devices, etc.
- 4) Phase sequence test at all the relevant points for connecting correct R, Y and B as per the supply authorities positions.
- 5) All panels to be tested for interlocks, control tripping and breakers to be tested for sequential tripping.
- 6) Capacitors banks shall be tested for all residual voltages on the terminal of the units and it should not exceed 50V after one minute.
- 7) Continuity tests shall be done for noting any short circuits and or earthing of phases.

Commissioning

- a) Prior to commencement of installation Work the Contractor shall obtain the approval of the substation drawings, if any and electrical layout prepared by him from the electrical inspector. The time involved in this is included in the overall completion period of the Contract.
- b) The Contractor shall obtain the written permission and sanction of commissioning the equipment and substation from electrical inspector and form consultants/PMC.
- c) All costs incidental to obtaining such sanctions shall be to the Contractor account.
- d) Contractor shall furnish all the necessary tests and test reports to the Electrical supply authorities and complete all formalities required to comply as per the Rules and regulations laid down for release of Electric supply. If called on, the Contractor shall carry out all such tests and prove the results to the entire satisfaction of the local and electric supply authorities.

All costs and expenses incidental to the release of electric supply shall be to the Contractor account and no demand whatsoever shall be to the employer, except for any security deposits that the supply authorities would deem necessary for charging of the line, except as may be provided for in the schedule of quantities. All such documents forwarded and or letter and or correspondence exchanged in this regard shall be made available for inspecting and the Contractor shall furnish 3 sets of documents and drawings for the employer records. After release of electric supply to employer premises, the Contractor shall furnish six sets of all tests declared to the supply Co. authorities and shall furnish all such documents, officially exchanged. Contractor shall also obtain and furnish the relevant completion certificate from the Electrical Inspector, Fire Officer and/or any other Authority thereof whichever may be applicable.

1.8.5 TECHNICAL SPECIFICATION:

ENGINE

Engine shall be water cooled tube charger with water cooler, under NTP condition of BS: 5514 with at overload capacity of 10% for one hour in any 12 continuous hrs Operation.

The engine shall complete with following accessories:

- a) Radiator with blower fan or Heat Exchanger.
- b) Corrosion inhibitor coolant.
- c) Paper element filter-fuel, lube oil and by-pass.
- d) Flywheel housing and flywheel to suit double bearing alternator.
- e) Spider flexible coupling.
- f) Dry type air cleaners and vacuum indicators.
- g) Residential Silencers.
- h) Stainless Steel exhausts flexible bellow.
- i) Motor driven priming pump.
- j) Electric Starter.

- k) Battery charging alternator.
- j) Solid-state potentiometer.

ELECTRONIC CONTROL PANEL (Displaying the following)

- > Battery voltage
- > Coolant water temperature.
- > Lubricating oil pressure.
- > Engine speed.
- > Safety Control: High water temperature (HWT)
- > (Trip & Indication): Low lube oil pressure (LLOP)
- > Over speed stop.

ALTERNATOR

Approved make, standard design alternator, suitably rated at 600 W/ required rating at 0.8 p.f.(lag), 415, 3 phase, 4 wire, 50 cycles/ sec. 1500 RPM, self excited and self regulated with brush less excitation, bank of voltage regulation + 2.5% of rated voltage, from no load to full load. Insulation class "H". the alternator generally conforms to BS: 5000/15:4722.

BASE FRAME

Sturdy, fabricated, welded construction, channel iron base frame for mounting the Engine and Alternator.

FUEL TANK

Fuel tank of suitable storage capacity sufficient to run the DG Set for minimum 8 hours, with mounting brackets, complete with level indicator fuel inlet and outlet air vent, drain plug, inlet arrangement for direct filling with pumping arrangement of suitable rating and capacity and set of 5 fit or as per the requirement of site long fuel hoses.

BATTERY SET

Set of Batteries: 12 Volts, 27 plates, dry, uncharged batteries with leads and / terminals.

CABLING WORKS

All cables from D.G. Set to AMF panel and from AMF panel to existing control panel and transformers of suitable rating as per the D.G. Set rating should be provided. The Tenderer should inspect the site before quoting the offer.

AUTO MAINS FAILURE CONTROL PANEL

Floor mounting, cubicle type, Automatic Mains failure panel, comprising of:

- TPN motorized Air Circuit Breaker for Mains for 2 Nos. of transformers and
- Nos. outgoing to control panel.
- TPN 4 Pole motorized Microprocessor based Air Circuit Breaker.
- TPN 4 pole motorized Air Circuit Breaker for Alternator.
- Natural Contractors for Main & Alternator.
- Voltmeter with selector switches for MAINS & ALTERNATOR.
- Ammeter with selector switch.
- Current transformer.
- Frequency meter.
- KWH Meter.
- KW Meter.
- Battery charger consisting of Transformer/Rectifier with surge protection.
- Selector switch for current adjust.
- Mains supply failure monitor (voltage sensing).
- Supply failure timer.
- Restoration timer.
- Control unit incorporating 3 impulse Automatic Engine Start/ Stop and "Failure to Start" lockout.
- Impulse counter with locking and reset facility.
- OFF/manual/Auto Test Selector switch.
- Control circuit ON/OFF switch.

LAMP INDICATION & TRIP ANNUNCIATION SCHEME

Mains ON	Yes	-
Generator ON	Yes	-
Load on MAINS	Yes	-
Load on Generator	Yes	
Low Lube Oil Pressure	Yes	Yes
High water temperature	Yes	Yes
Set/Fails to Start (with Alarm)	Yes	
Mains ON	Yes	-

Push Buttons/Switches for :

- > Engine Start/Stop
- > Alternator breaker ON/OFF
- > MAINS Breaker OFF
- > AMF Test

WORKING OF THE PANEL

a) Auto Mode

When the mains supply fail, the "Mains supply failure Monitor" operates after a preset time of approx. 10 Sec. This actuates the "3 impulse Engine Start" control. We do not recommend plug type relays. The control unit gives three starting impulses with an interval of 1-5 sec. If the engine starts at the first impulse, the unit shuts off. If not, it gives further two impulses, during which time, if the engine, does not start, the unit shuts off, activating the audio-visual alarm for "Set fails to Start".

b) Test Mode

By operating the "AMF Test" Push Button, the conditions of Mains Failure are stimulated as explained in Auto Model above, without disturbing the supply through Mains switchgear.

ENGINE INSTRUMENT PANEL

- a) Starting switch with key.
- b) Lube oil pressure gauge.
- c) Battery charging ammeter.
- d) Charge regulator.
- e) Set of documents comprising spares part book maintenance.

Mains supply monitor to identify low voltage/complete failure and initiate necessary single for operation of automatic control gear.

- a) 1 set window Annunciation's with audio visual alarm and trips for:

- a) High Water Temp.
- b) Low Lube oil pressure.
- c) Over speed stop.
- d) Set fails to Start.
- ii) 1 No. Electronic Hooter.
- ii) 1 Set Push Button - Hooter Accept/Fault Clear.
- iii) 1 No. control switch (ON/OFF for DG manual Control)
- iv) 1 No. mode selector switch (Auto/Manual/Test Off)
- v) 1 Set indicating lamps for load on set, load on mains, etc.
- vi) 1 No. battery charger cossetting of:
 - a) Transformer
 - b) Rectifier
 - c) D.C. ammeter
 - d) D.C. Voltmeter
 - e) Charge range selector switch (Trickle/Boost/off)
 - f) Lamp for battery charging indication
- vii) 1 Set instrument fuses.
- viii) 1 Set bus bar of adequate capacity.

SOUND PROOF ENCLOSURE

Sound proof enclosure of DG set shall be fabricated out of M.S. 16 gauge sheet steel and special type of sandwich material shall be used for sound absorption. DG set can be operated without any duration. The DG set shall be suitable for direct

mounting inside MS fabricated container with proper clamping, mounting and supporting arrangement. M.S. sheet metal enclosure with hinged/sliding type doors shall be provided for protection from sound, dust and rain.

The Salient features of outdoor D.G. Set Canopies (for noise control) are as under:

- > Enough space to house DG Set panel and fuel tank outside canopy.
- > Provision of Air-Intake and Air-Exhaust Silencer(S) for preventing leakage of sound.
- > Openable Doors for easy access to virtually every part of DG set for comfortable.
- > Maintenance Doors are double wall all steel insulated SOUND REDUCTIN DOORS.
- > Provision of additional screen and hoods for multi medium noise suppression.
- > Two layers of sound - suppressing elements:
 - a) Non-Ferrous sheet sound barrier.
 - b) Rock-Wool 48 Kg/cu. M. 100 thick.
 - c) Total thickness of panel - 100 mm.
- > High performance most comfortable sound - reduction level to 70 db at a distance of 3 meters.
- > Provision for forced ventilating hot air coming out of engine.
- > It can be dismantled completely & engine is accessible from all the sides.

SPECIFICATION OF ACCOUSTIC ENCLOSURE CANOPY

The D.G. Set is mounted on anti mounts and placed on firm ground. A specially designed transportable acoustic chamber encloses the generator set. The acoustic chamber attenuates the noise of the generator set. The weather proof acoustic chamber is designed to reduce the noise level to an average of 70 ± 5 db (A) at three meter away from the enclosure as measured in free field condition. The enclosure shall be designed to the following requirement:

- a) Modular type weather proof design so that this can be installed in open space (No engine room is required).
- b) Sufficient space around the genset to meet the day to day maintenance of

- engine, alternator, batteries etc.
- c) Suitable grills for air suction for engine cooling/aspiration, outlets for hot exhaust gases, air for ventilation, air inlet and outlet without affecting the engine performance etc.
 - d) Frame Work made out of heavy gauge steel sections and suitably reinforced.
 - e) Proper forced ventilation arrangement to maintain enclosure temperature within permissible limits.
 - f) Electric points, illumination lights, blower fans etc, inside the chamber.

The external surface of the enclosure is cladded with CRCA steel sheets and treated with anticorrosive paints. The interior is lined with fire proof, vermin proof sound absorbing material suitably retained in position using perforated sheets/galvanized wire mesh. The acoustic enclosure is designed and fabricated to meet the specification and shall Work at the optimum condition and maximum efficiency with proper fresh air blowers. Adequate number of doors with lockable arrangements are provided for easy access. All the doors are provided with rubber gaskets for weather and sound proofing. The bolted structure of the enclosure facilitates it easy shifting from one place to another if required. The acoustic chamber shall be painted as per the customer colour choice.

MATERIAL USED FOR CONSTRUCTION

- A) The outer cover for the acoustic enclosure shall be made out of ribbed type 1.6 thick CRCA steel sheet. Size of the rib shall be 80 mm x 20 mm.
- B) All perforated sheets used shall 1 mm thick galvanized iron sheets with 3 mm hole dia and 5 mm diagonal pitch.
- C) The sound absorbing acoustic materials used shall be resin bonded mineral wool/rock wool. It will have a density not less than 65 Kg./Cu.mtr.

1.8.6 SCOPE OF INSTALLATION & COMMISSIONING

For erection of the equipment in the power house, following Work shall be undertaken.

1. DG Room layouts, preparation of detailed engineering drawings for foundation, electrical panels and other accessories etc.

2. Supply and installation of exhaust pipes from the engine, with necessary supports as per our layout and lagging of pipes. To a maximum of 6 mtr. additional length will be charged extra.
3. Supply and installation of fuel piping from the engine to fuel tank & return.
4. Supply and laying of power cables between alternator & DG panel.
5. Necessary control cabling between DG set and DG panel.
6. Training of your personnel at site.
7. Unloading and positioning of the DG set.
8. The scope of works also includes all types of works to complete the erection and successful commissioning of DG set at site such as:
 - a) All civil works including mounting on MS frame etc. as per the directives of Engineer-in-charge.
 - b) Earthing along with earth pits.
 - c) Outgoing power cables.
 - d) Obtaining approval from concerned authorities.

1.8.7 ESSENCE OF WORK

Following given points are the essential works of Contract for the subject Work and successful agency will be responsible for completing the same without any extra cost within stipulated Contract period.

1. Even though the technical specification and other details are specified in the Tender document for carrying out the subject Work, the successful agency will be supposed to design the scheme in detail for carrying out the subject Work, matching with the existing system and the scheme prepared should be got approved before starting the execution of Work, the agency should visit the site before quoting the offer to guess the exact quantum of Work.
2. After finalization of the scheme the agency should obtain the required approvals to the various makes of material to be supplied under the Contract before procurement. The D.G. Set and other material to be supplied under this Contract should be got tested at Manufacturers unit in presence of Engineer-in-charge or his representative.
3. The agency should submit the Bar Chart within a period of one week after

issue of Work order.

4. It will be the responsibility of the successful agency to complete the statutory requirements from concern authorities for carrying out the subject Work completely as per the requirement of Engineer-in-charge without any extra cost.

5. Proposed D.G. Set under the present Contract shall be installed at STP. For erection of the same, successful agency will be responsible for carrying out the required foundation work and other connected civil Work also. This foundation work and civil work should be carried out in consultation with concern civil authority completely as per the requirement of Engineer-in-charge.

6. Successful agency will be responsible to provide required connecting cables of appropriate size and length to be connected between transformer, AMF panel and D.G. Set etc. completely as per the scheme approved by Engineer-in-charge. This Work will be included in the total scope and no extra payments will be made against this Work

7. After completion of erection and commissioning Work of proposed rated designed D.G. set, successful agency will be responsible for operating and maintaining the installation for a period of five years (including defects liability period of two year).

8. The agency shall carry out the Work as per ISO 9001-2000 procedure and maintain necessary records completely as per the directives of Engineer-in-charge.

**TECHNICAL SPECIFICATIONS: ELECTRICAL &
INSTRUMENTATION WORKS - PART B**

1.0 Scope

The bidder's /contractor's scope covers the design, shop testing, supply, transport, storing at site, erection, testing and commissioning of all electrical and instruments required for the plant, as per enclosed General Specification, Specific Requirement, typical power distribution scheme and typical control system architecture.

Where there is any contradiction between General Specification and Specific requirements mentioned in this document, the specific requirements will rule the project requirement.

2.0 Design Basis

2.1 The Bidder/ Contractor shall strictly follow the typical power distribution single line diagram, which is to be proposed by him, and approved and accepted by Employer.

The bidder shall visit the site to satisfy himself about availability of voltage level, its condition, its probable route, etc. before quoting. The Employer will provide 11 KV, 50 c/s, 3 phase electrical power up to electrical meter within the premises. From this metering point onwards the successful bidder shall extend 11KV supply up to main substation and further 433 V(step down) supply up to MCC room (Motor Control Centre).

2.2 All the incomers of substations shall be suitably electrically as well as mechanically interlocked as per scheme.

2.3 LT panels shall also have two EDO (Electrical Draw Out), ACB (Air Circuit Breakers) incomers and one no. EDO, ACB bus coupler. All the main pumps/drives and standby pumps shall be distributed between two LT bus section equally so that

in case of failure of one bus section, other standby motors should get power supply from other bus section.

2.4 Bidders shall follow the BIS guideline for voltage rating of motors while designing and selection of electrical motors. All motors shall be of squirrel cage type.

2.5 All motors shall be provided with class-F insulation and their temperature rise shall be limited up to Class-B. All motors above 100HP/75KV shall be provided with RTD's (at least two RTD's per winding) earth leakage protection, comprehensive micro process based protection having locked current /over load, negative phase sequence relay, under load, over current, earth fault, start nos., transit currents etc.

2.6 All HT & LT cables shall be designed and selected after considering a minimum de-rating factor of 0.65. Exact de-rating shall be calculated taking into consideration designed ambient temperature, grouping and minimum size as per fault level calculations of synchronised DG with grid). Bidder shall carryout detailed fault level calculation of main generating station and upto all distribution points.

2.7 Bidder shall carry out the earth resistivity test on his own and based on this result they should design the total earthing system to maintain a overall resistance value less than one ohm.

2.8 The electrical and instrumentation in gas handling area like compressors etc. shall be flame proof type and strictly adhere to CPCB norms.

2.9 Substation design shall incorporate all safety aspects and shall be provided with power distribution agency metering room, switchgear room, separate fence, gates, internal access roads, lighting, earthing, power factor correction, lightning protection, cable trenches, equipment foundations, transformer oil soak/drain pits, galvanized steel latticed structures/gantries, gravel etc. Two supplies from power distribution agency shall be made available and normally any one source shall supply power to the entire system.

2.10 Noise level (db levels & insertion level) inside and outside blower room shall be strictly as per latest amended pollution control board norms applicable at installation time. Whatever extra equipments required like scrubber, acoustic shall be provided to meet statutory guide lines as well as building should be able to accommodate all equipments.

2.11 The Control system and instrumentation for the total plant shall be provided as per typical control system architecture provided with this tender.

2.12 HT cabling shall be done underground with top of HT cable minimum 1.0 meter below plant ground level. The protection above HT cable shall be provided as per latest revision of IS standard.

LT cable/ control cable/ lighting cable inside the plant shall be done on overhead cable tray mounted on steel structure etc.

2.13 Bidder shall get the short circuit fault level data at 11 kV, from power distribution agency and shall do the fault level calculation and Relay co-ordination scheme for the entire plant accordingly. Bidder shall provide minimum protection on HT side as per standard relay protection scheme enclosed herewith. In case some additional protections other than indicated in drawing, are required; same should be added. Wherever transformer size is 2 MVA or bigger, than differential protection shall be provided.

2.14 Measuring instruments shall be provided by bidder as per standard measurement scheme enclosed herewith.

2.15. LT capacitor bank shall be provided with automatic power factor correction system. Its panel shall incorporate timer circuit to allow capacitor to discharge at minimum 50V before re-energisation of any individual bank.

2.16. Capacitor bank shall consist of many small capacitors so that banks can be in circuit as per system p.f requirement with the help of Automatic Power Factor Correction relay. Minimum 0.99, preferably unity power factor shall be maintained at power distribution agency meter on H.T. Side. Capacitor bank calculations submitted along with bid shall also take into consideration the transformer impedance. Each capacitor should be able to switch ON either in manual or auto

mode independently.

2.17. All the protection relay of 11kV/ 6.6 kV/ 3.3 kV HT panel shall be of microprocessor based except master tripping relay and check supervision relay.

3.0 Bidder's Obligation

Bidder shall provide preliminary details for the sr. items 3.1, 3.6 & 3.33 given below during bidding stage. All other remaining details shall be provided during detailing. However, if Employer requires any further details during technical bid evaluation stage, the bidder shall provide the same.

- 3.1 Load list (as per enclosed typical format)
- 3.2 Maximum demand in KVA with duration (period) of the plant.
- 3.3 Minimum demand in KVA with duration (period) of the plant
- 3.4 Normal demand in KVA of the plant.
- 3.5 Detailed Bill of material for electrical as well as instrumentation scope of work.
- 3.6 P & I diagram of the total plant.
- 3.7 Instrument index (as per enclosed typical format)
- 3.8 Input/ Output List (as per enclosed typical format)
- 3.9 Instrument Data sheet for each tag No.
- 3.10 Interlock logic diagram
- 3.11 Control system architecture.
- 3.12 Instrument air requirement.
- 3.13 Uninterrupted power supply (UPS) capacity requirement.
- 3.14 UPS capacity and its battery backup calculation sheet.
- 3.15 Lighting fixture capacity and quantity calculation.
- 3.16 Single line diagram for HT Power, LT Power. (main panel), L T distribution boards.
- 3.17 Single line diagram for lighting and small power.
- 3.18 Cable schedule of total plant, along with voltage drop calculation and deratings.
- 3.19 Operating power factor of each equipment.
- 3.20 Power factor improvement capacitor calculation.

- 3.21 H.T Panel Board Data Sheets.
- 3.22 LT Panel board (NDAC, MCC etc) Data Sheets.
- 3.23 HT Cable, LT cable, control cable, telecommunication cable Data Sheet.
- 3.24 Transformer Data Sheet.
- 3.25 UPS Data Sheet.
- 3.26 Battery and Battery Charger Data Sheet.
- 3.27 ACSR Conductor Data Sheet.
- 3.28 Guaranteed Power generation by Gas Engine.
- 3.29 Bus Duct Data Sheet
- 3.30 Power mounted Isolator Data Sheet.
- 3.31 Maximum Power consumption of the plant per day.
- 3.32 Minimum power consumption of the plant per day.
- 3.33 Guaranteed power consumption of the plant per day.
- 3.34 Transformer capacity calculation sheet.
- 3.35 Battery Charger Capacity Calculation Sheet.
- 3.36 Battery Capacity Calculation Sheet.
- 3.37 Motor List (as per typical format enclosed herewith).
- 3.38 Control Valve sizing calculation sheet.
- 3.39 DDC sizing calculation sheet.
- 3.40 GA drawings of all electrical panels like HT panel, Transformer, Diesel Generators, NDAC, MCC, Battery chargers and batteries, AC distribution board, DC distribution Boards, UPS and its batteries, Pole mounted Isolators, Lighting Arrestors etc.
- 3.44 Typical drawings of earthing station.
- 3.45 A drawings of all analysers, control room equipments etc.
- 3.46 Typical drawing HT cable laying under the ground.
- 3.47 Typical structural drawing showing LT cable tray for power, control etc in outdoor areas.
- 3.48 Substation layout for each section, D G layout with appropriate clearances as per IER and
appropriate clearances for maintenance.
- 3.49 Control room layout.

3.50 Room size and quantity for total plant electrical and instrumentation work.

3.51 List of Safety Items.

4.0 Indian Standards / Other International Standards

For the benefit of bidders, a few Indian Standards and Codes of practices and other international standards are listed below. Unless otherwise noted, equipment/devices/accessories /installations/ testing etc. shall comply with relevant standards/codes mentioned herein. Where Indian Standards are not available equipment/ devices etc. complying with relevant British or IEC standard or ISO standards shall be proposed. While referring to any standard, the latest revision/edition shall govern. Bidders are advised to include in their bid a list of equipment/devices and corresponding standards to which they conform. Translation in English of standards, which are available in other languages, shall be furnished along with the bid, in such cases the English translation shall govern.

4.1 List Of IS & Other International Codes (For Electrical Equipment / Accessories)

IS 5	Colours for ready mixed paints and enamels
IS 3	Three phase induction motors
IS 374	Electric ceiling type fans and regulators
IS 694	PVC insulated cables for working voltages up to and including 1100V
IS 722	AC electricity meters
IS 1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS 1271	Thermal evaluation classification of insulating material
IS 1293	Plugs and socket outlets of rated voltage up to and including 250V and rated current up to and including 16A
IS 1364	Hexagon head bolts, screws and nuts of product grades A and B.
IS 1534	Ballast's for fluorescent lamps
IS 1554	PVC insulated (heavy duty) electric cables
IS 1777	Industries luminaires with metal reflectors
IS 1913	General and safety requirements for luminaires

IS 2086	Carrier and bases used in rewire able type electric fuses for voltages up to 650V
IS 2223	Dimensions of flange mounted AC induction motor
IS 2253	Designation for type of construction and mounting arrangement of rotating electrical machines
IS 2254	Dimensions of vertical shaft motors for pumps
IS 2259	Methods of tests for determination of insulation resistance of solid insulating materials
IS 2419	Dimensions for panel mounted indication and recording electrical instrument
IS 2544	Porcelain post insulators for system with nominal voltages greater than 1000V
IS 2551	Danger notice plates
IS 2667	Fitting for rigid steel conduits for electrical wiring
IS 2705	Current transformers
IS 2713	Tubular steel poles for overhead powerlines
IS 2834	Shunt capacitors for power systems
IS 3156	Voltage transformers
IS 3231	electrical relays for power system protection
IS 3725	Resistance wire, tapes and strips for heating elements
IS 3854	Switches for domestic and similar purposes
IS 3961	Recommended current rating for cables
IS 4029	Guide for testing 3 phase induction motors
IS 4691	Degree of protection provided by enclosure for rotating electrical machinery
IS 4728	Terminal marking and direction rotation for rotating electrical machinery
IS 4889	Method for determination of efficiency of rotating electrical machines
IS 5216	Guide for safety procedures and practices in electrical works
IS 5578	Guide for marking for insulated conductors
IS 6098	Method of measurement of air borne noise emitted by rotating electrical machinery

IS 6875	Control switches (switching devices for control and auxiliary circuits, including contractor relays) for voltage up to and including 1000V AC and 1200 V DC
IS 7098	Cross - linked polyethylene insulated PVC sheathed cables
IS 8623	LV switchgear and control gear assemblies
IS 828	Circuit breakers for over current protection for house hold and similar installations
IS 10322	Luminaries
IS 12729	general requirements of switchgear and controller
IS 13032	MCB boards for voltage up to and including 1000V AC.
IS 13947	Low voltage switcher and controller
IS 732	Code of practice for electrical wiring installations
IS 3043	Code of practice for earthing
IS 3646	Code of practice for interior illumination
IS 10118	Code for practice for selection, installation and maintenance of switchgear and control gear
IS IEC 309	Plugs, socket outlets and couplers for industrial purpose.
IS 2026	Transformers
IS 13118	Vacuum circuit breakers
For all other process equipments and instruments contractor shall follow IS / ISO specifications and submit a copy of the same.	

5.0. Clearance from Statutory Authorities

Bidders shall note that the successful bidder shall be responsible for obtaining statutory clearances from all the relevant bodies (such as electrical inspector, Safety, Pollution Control Board, Fire Insurance and Explosive Department Authorities, etc.). Payment in respect of fees, deposit, etc., of such bodies shall be made by successful bidder. Employer shall assist the contractor in obtaining such clearances expeditiously by way of issue of introductory letters to relevant bodies but this will not absolve the Contractor from his responsibility of obtaining in writing clearances mainly from Electrical Inspector, Chief Explosive Officer,

Pollution Control Board or any other local/ central authority entirely at his own cost. No extra sum will be paid for these services. However fee deposited to power distribution agency will be reimbursed by Employer.

6.0 Contractors License:

It shall be the responsibility of the contractor to obtain necessary license / authorization / permit for work for his personnel from the licensing board of the state. The persons deputed by the contract's firm should also hold valid permits issued or recognized by licensing board of the state where the work is to be carried out.

7.0 Workmanship:

The contractor shall ensure workmanship of good quality and shall assign qualified supervisor/ engineers and competent labour who are skilled, careful and experienced in carrying out similar works. Employer shall reserve the right to reject non-competent person/s employed by the contractor, if the workmanship is found unsatisfactory.

8.0 Power Distribution Philosophy:

The bidder shall design the power distribution scheme for this site on the basis of following guidelines and single line diagram. Voltage drop from transformer output to last point in electrical distribution shall not be more than 5%. Voltage drop in any cable for installed load or any single circuit for installed load shall not be more than 2%. Only aluminium conductor with PVC insulation armored cables shall be used for size 2.5mm² and above. All power cables upto 2.5mm² shall be copper conductor PVC insulated armored cables.

8.1 An indoor substation shall be planned to house switchgears for incoming and outgoing power supply circuits, metering equipments, communication equipment, control panels, auxiliary power supply distribution boards, DC system equipment etc. The following voltage of load factor and diversity factor shall be considered for calculating the maximum running load. The sizing of transformer shall be included along with the bid.

LOAD FACTOR

Main Pump Motor	:	0.9 (or as per BKW)
Aux. Loads	:	0.9 (or as per BKW)
Lighting loads	:	1.0
Socket outlet, receptacle Diversity Factor	:	0.50

DIVERSITY

Main pump motor for working loads	:	1.0 (or as per process requirement)
Lighting Loads	:	1.2
Socket outlet, receptacle	:	1.2

8.2 Main incomer switchgear in various plant/process areas shall be fed by duplicate (two), 100% capacity feeders and outgoing feeders shall be so designed that at least 20% spare subjected to minimum of one feeder of every type shall be available. All control voltage inside switchgear panel shall be at 230V AC for Contactors and control supply. Single line diagram of all panels shall be attached with bid giving cable sizes in single line diagram.

8.3 DC system equipment (comprising batteries, chargers & DC distribution board) with adequate capacity shall be proposed for protection / control circuits and other vital devices of each substation. Further, in plant areas / substation a few lighting fixtures, suitable for operation on battery voltage shall be proposed in strategic areas. DC system, calculation of DC Battery size, DC battery charger, Voltage should be attached with the bid.

8.4 Following protections for incomer feeders in main MCC location for each process area of the plant. Each MCC shall be provided with 4 Pole two incomers and bus section with draw out ACB/MCCB as incomer. MCC's shall be metal clad floor mounted, with cable entry from bottom (preferred) and environmentally protected to IP-52. MCC shall have fault rating of not less than the applicable fault levels. The two incomer neutral shall completely be isolated by using 4 pole ACB/MCCB.

Mechanical and electrical interlocking shall be provided between the incomers and the bus section ACB/MCCB to prevent parallel operation of main switchgear feeders. MCCs shall be housed within brick built buildings segregated from injurious effects of process fluids/gases are present. The major components of

each starter shall comprise:

- Door interlocked isolator
- Fuse gear/ MCCB
- Contactor, overload relay with single phasing protection.
- Start/ Stop push button.
- Local/ remote selector switches (if applicable)
- Manual / off/ auto sector switch.
- Ammeter as per starter requirement
- Indication light for run, trip, emergency stop operated, power On, run dry protection operated (where such tanks are used)

i) Incomer feeder shall have electrostatic / microprocessor based control releases for over current, short circuit, earth fault with time delay and these releases shall directly work on tripping mechanism of drawout air circuit breaker. Outgoing feeder up to 630 Amps shall be switch fuse unit / MCCB and beyond 630 Amps shall be air circuit breaker. All Outgoing Air Circuits Breakers will be manual drawout type.

ii) Each motor upto 5 KW shall have DOL starter with O/C, short ckt protection, over load relay with single phasing protection along with ammeter, provision for remote start/stop. Overload relay shall be reset type from front of panel. All starters component shall follow type-II coordination chart of established manufactures with components of same make. Each starter shall have On/Off/Trip indication. All necessary selector switches like auto manual switch and local remote switches shall be installed.

iii) Motors above 5 KW and upto 30 KW shall have Star / Delta starter with O/C, short ckt protection, over load relay with single phasing protection along with ammeter, provision for remote start / stop O/C relay shall be reset from front of panel. All starter components shall follow type-II coordination chart of established manufactures with components of same make. Each starter shall have on/off/trip indication. All necessary selector switches like auto, manual switch and local, remote switches shall be installed.

iv) Motor from 37 KW & above shall have auto transformer or Soft starter (FCMA) type or electronic type start and auto transformer shall have taps at 40%, 60% and 80%. Over load relay shall be reset from front of panel. All starter components shall follow type-II coordination chart of established manufactures with components of same make. Each starter shall have on/off/trip indication. All necessary selector switches like auto, manual switch and local, remote switches shall be installed.

v) Motor from 75KW and above shall have numeric type micro processor based relays along with short circuit protection. Each starter shall have on/off/trip indication. All necessary selector switches like auto manual switch and local, remote switches shall be installed. Since these motors will be slip ring, necessary either liquid rotor starter or air break contactors in minimum faultages shall be installed.

8.5. Cables proposed shall be suitable for operation on earthed/ unearthed system as applicable. LV cables shall be armoured PVC insulated. Outer sheath of all cables shall be of general purpose PVC and shall be of extruded type meeting latest IS-1554 requirements. The cable shall be designed after taking de-rating factors of ambient, grouping into consideration for its design. Power cables of cross section above 2.5 sq. mm shall be with aluminium conductors. All cables of cross section up to 2.5 sq. mm shall be with copper conductors. Unless otherwise stated all the cables shall be armoured. LV cables shall be of the armoured heavy duty type and of 1100 V grade. Voltage drop on cable for installed current shall not exceed 2% on installed load. Design ambient temperature shall be taken as 47°C. All cables shall also confirm to the relevant fault level of switch board for one second and supporting calculations must be submitted for fault level.

8.6 Cable Terminations

i) For termination of MV cables, single compression type glands shall be used for indoor locations. Glands shall be of brass, Lugs of Al / Cu or tinned copper shall be used as applicable, lugs shall be properly crimped on conductors. All glands used must be of heavy duty type.

ii) In outdoor areas, except within outdoor sub station area, cables shall be laid

directly buried between building entry/exit points. Within buildings, cables shall be laid on cable trays to be supported from building walls columns/ beams/floors / ceilings. In outdoor sub station area, cables shall be laid on cable trays in build up cable trenches. Ladder and perforated type cable trays shall be proposed. Ladder type cable trays widths shall be restricted between 300 mm and 600 mm. Perforated cable trays widths shall be restricted between 100 mm and 250 mm. Side members of ladder type cable trays shall be fabricated using structural steel angles of at least 6 mm thick. Perforated cable trays shall be of the formed type made from 2 mm thick sheet steel. For supports, structural angles or channels of appropriate strength shall be proposed. Vertical runs of cable trays shall be enclosed using perforated sheets as above. Cable trays, supports and covers shall be painted with epoxy paint of shade acceptable to Employer. Tray width shall be so sized that at least 30% margin is available for addition at later date. This distance between the cables shall be minimum equal to outer dia of cable.

iii) At road crossings hume pipe/s of adequate size shall be provided at a depth of 1000 mm (center line depth) of passage of cables, earthing conductors etc. At building entry points pipe sleeves of GI or PVC shall be provided for the passage of cables and earthing conductors, such sleeves shall have projections on either side to facilitate extension.

9.0 Illumination:

9.1 All internal and external areas shall be provided with lighting. The illumination levels to be achieved shall be as follows:

Office and labs	:	300	Lux
Switchgear Room	:	200	Lux
Control Room	:	300	Lux
Pump House	:	200	Lux
DG set Room	:	200	Lux
Chemical and General Store	:	150	Lux
Chemical Plant Room	:	200	Lux
Other indoor areas	:	100	Lux
Outdoor plant from and walkways	:	50	Lux

Building entrance	:	100	Lux
Indoor Plant Area	:	200	Lux
Outdoor Plant Area	:	50	Lux
Transformer Area	:	100	Lux
Roads	:	10	Lux

Fluorescent luminaries shall be used primarily for internal lighting. High pressure vapour or metal halide type luminaries shall be used in indoor application where their use is appropriate. If mercury or metal halide is used in indoor then they should be supplemented with fluorescent luminaries to assure that minimum illumination levels are maintained following momentary power dips. All other internal areas shall be lit with fluorescent luminaries. Where specific recommendation of lux level are not covered above, illumination level in such areas shall be finalized in consultation with Employer. Contractor shall be required to measure levels of illumination after completion of lighting installation work and short fall in illumination level shall be made good by the contractor. Complete set of calculations showing, room, index, copy MF shall be given during detailed engineering.

9.2 Switches / sockets of piano type shall be used in general and in offices of staff, control room, MMI room, decorative modular switches shall be used. Suitable fans shall be provided in rooms/ plant areas as per Employer/CPWD standards. For exhaust fans it must be provided in panel rooms, pump rooms, chemical rooms, stores, toilets and at least 20 air changes per hour must be maintained.

9.3 The following type of lighting fixtures shall be proposed:

- a) Decorative type 2x36W fixtures for fluorescent luminaries inside office/ administrative buildings and control rooms.
- b) Corrosion resistant fixture with canopy made of FRP for fluorescent luminaries for corrosive areas like chlorine handling or chemical store or area with corrosive smell/gases etc.
- c) Industrial type vitreous enameled fixture for fluorescent luminaries inside 415V switchgear, MCC room and pump house.
- d) In outdoor process areas, lighting fixtures shall be sodium vapour type

Contractor

No. of correction

Executive Engineer

subjected to minimum of IP protection class.

- e) All outside lights as plant field lights, building outside lights, flood lights etc. which are to be switched on only during night hours should be controlled through photo cell/ clock switch installed at a central place. All lights shall have minimum IP65 protection class.
- f) Street lighting wiring shall be through buried underground.
- g) All bulb fittings (except fluorescent lamps) will have screw type caps.
- h) For outdoor lighting, the lighting feeder shall be operated through a contactor, controlled by photocell/ clock switch and shall also have a manual by pass switch.

9.4 Luminaires shall be installed to permit ease of maintenance i.e. it shall not be necessary to shut down plant in order to carryout maintenance or to access luminaries located over areas of water etc. The contractor shall provide all equipment necessary to carryout maintenance on the lighting installation and demonstrate its operation to the satisfaction of Employer.

9.5 Indoor lighting circuit will be arranged in such a way that 50% lighting can be put off in each room through switches. All lighting circuits will be wired with 2.5sq.mm. stranded copper wire or through 2.5 sq.mm. armoured cable laid in cable trays. Sub circuit from switch to fixture could be wired with 1.5 sq.mm. stranded copper wire in MS conduits or armoured copper cable of similar size provided total voltage drop in any lighting distribution board to last lighting point shall not exceed 2%. All lighting circuits will have separate neutral, separate earth from Lighting Distribution Board.

9.6 For illumination of roads, outdoors areas where operation of equipment or units required and substation area, lighting fixtures of appropriate type (such as street lighting type, flood lighting type, post top lanterns etc.) incorporating high pressure sodium vapour lamps shall be proposed. Street light poles shall not have less than 7500 mm height above the finished road level and the arm shall not project more than 1200 mm along the road width. Poles of bigger heights may also be used if some outdoor areas are to be illuminated. Poles of 4 / 4.5 Mtrs using

post top lantern may be used in gate office, walk way or in front of office area. Complete area, streets, lanes, boundary shall be covered with street lighting.

9.7 Receptacles (Lighting & Small Power) :

a. Decorative and industrial type units of above shall be proposed in all plant areas, offices, stores, workshop, plant room and they shall be located at least two numbers in each room. Distance between two receptacles shall not be more than 8 - 10 mtr. All small 5 amps 5 pin lighting & small power sockets shall be wired by multi stranded copper wire of 2.5 sq. mm laid in rigid MS conduits along with earth wire of 1.5 sq.mm flexible copper wire or equivalent size armored cables. All wiring shall be coded with Red, Yellow, Blue & Black as per the phase used. If required, wiring can be done alternatively through armoured copper cables of similar size laid in MS perforated trays of minimum 2.0 mm thick.

b. Three phase power receptacles (convenience outlets) suitable for operation of 415V, 3 Phase 4 wire, 50 Hz power supply shall be proposed. In indoor areas one such unit shall be provided to cover areas of 20 meter radius (or at least one in each room housing plant items) and in outdoors areas on such unit shall be provided at 50 meter interval. Actual requirement of such units shall be finalized by Employer during detailed engineering. One three phase receptacle shall be provided near entrance of each building for utilities like welding.

c. Single phase 15 Amp 5 Pin / 6 Pin receptacles will be provided in each room and in halls they will be provided in such a way that with 15 meter cord we should reach every place in building. These shall be wired with 4 sq. mm copper earth wire in MS rigid conduits along with 2.5 sq. mm earth wire. Not more than two sockets shall be looped in one circuit. Alternatively they can also be connected through armoured cable of 4 sq. mm running in appropriate cable trays.

9.8 Separate lighting panels and lighting distribution boards shall be installed and they shall not take tapping for power from motor control centers or power distribution boards.

10.0. Earthing & Lightning Protection.

10.1 Bidders are advised to carry out soil resistivity measurement for designing

the earthing system. Further, bidders are also required to study the guidelines in respect of lightning protection covered in relevant Indian Standards and accordingly include proposals for the same. The bidder shall make sure that earthing resistance value for both neutral conductor & body earthing shall be less than one ohm. All earthing station shall conform to latest amended IS 3043.

10.2 The Contractor shall provide an earthing installation at each site. Protective conductors shall be provided for all electrical installations and associated mechanical plant, exposed steel work and buildings. Protective conductors shall be provided in accordance with the requirements of IS-3043 or equivalent. The earthing system shall be designed for the earth fault current occurring at the point of supply. The neutral point of the 11/0.433 KV transformer secondary windings shall be solidly earthed. The calculation of earthing system and earthing valves must be submitted at detailed engineering stage.

10.3 The electrical installation shall be connected to the general mass of the earth by an earthing electrode. The earth electrode system shall be established adjacent to the transformer compound. GI plate earth electrodes shall be proposed in earthing system. MS conductors with allowance for corrosion shall be used for conductors to be buried in ground and they shall withstand fault for three seconds. GI conductors for earthing shall be used for above ground installations. Touch and step potentials shall be kept within permissible limits as per IS and this should be supported with earthing calculations. No earthing resistance shall be less than one ohm. Size of earthing conductor shall be arrived as per calculations subjected to minimum rating suggested below:

a. Main switch board and stand bye	:	50 x 6mm GI Flat
b. Interconnection to lighting protection system	:	50 x 6mm GI Flat
c. Interconnection to MCC's	:	50 x 6mm GI Flat
d. Interconnection to control panels	:	25 x 3mm GI Flat
e. PF correction panel	:	50 x 6mm GI Flat
f. Local push button	:	14 SWG GI
g. Lighting distribution boards	:	4 SWG GI

h. Lighting & receptacle system	:	12 SWG GI
i. Outdoor street lighting	:	8 SWG GI
j. Ladder rack and cable tray at suitable points	:	25 x 3mm GI
k. Hand rails and metallic structure	:	25 x 3mm GI
l. Steel structure comprising storage tanks	:	25 x 3mm GI

10.4 The complete plant shall have lighting protection in the form of lighting finials, horizontal earth continuity conductors, verticals risers, inspection links, earthing pits as per IS 3043. As detailed lightning calculations shall be submitted at the detailed engineering stage.

11.0 Communication:

Bidders are required to provide communication facilities at site. The site shall also have facility to communicate with outside agencies through local telephone network. Bids shall take into account the above requirement. Bidders are free to propose means of communication within site; however communication with outside agencies shall be through local telephone network only.

12.0 Instrumentation

12.1 Introduction to Instrumentation

Employer wants to have latest technology with compatible automation system ON LINE to run the plant from a single location. A typical control system architecture is enclosed with bid which is to be strictly followed by bidder/ contractor while designing the control system and instrumentation.

AIM: To provide latest technology for ON LINE monitoring and control of various parameters Employer hopes to achieve following aim:

- Improvement in effluent quality
- Proper monitoring and correction
- Low manpower
- Generation of all faults and trends
- Correct display of input raw material and output treated effluent
- Long-term historical storage of process data

- Analysis and graphical plots of historical data
- Prevention maintenance management
- Inventory control
- Maintain plant operation summaries
- Maintain record of generation of methane gas and consumption.
- Improve plant efficiency and increase the plant life.

Bidder shall provide one centralised control room with PLC based SCADA system based on latest technology with following minimum feature.

- Two nos. of Pentium-IV PC with 22" colour monitors with one no. LaserJet printer.
- All field instruments shall be controlled by centralised control room.
- In case of PC failure, the local control shall be able to control all the field instruments.
- All Analysers / Transmitters shall have local display as well.
- SCADA should have graphics, alarm reports, process trends, history, etc.
- Minimum 15% spare capacity for each analogue and digital I/O's shall be provided in PLC.

Instrumentation control system shall have dedicated earthing and shall not be joined with electrical earthing. Control system earthing shall have ideal zero voltage value.

- On-line flow measurement shall be done at inlet of sewage treatment plant.
- All the valves, motors penstock shall be electrically as well as electrically operated except valves on suction line of pumps / blowers / compressors, which shall be manually operated. Scour valves on rising main (s) shall also be manually operated.
- A central control room shall be provided with air conditioning. The control room shall be located inside the plant at convenient location.
- Contactor shall submit the details of Field Instruments, Panel Instruments, Including Type, Makes, Model No., Range etc. suitable for above mentioned

application.

- Bidder shall submit the complete control system architecture including type of control, number of analogue/digital I/OS, type of communication bus, retentively level etc.

12.2 Large General Product Description:

The Automation System shall integrate multiple sewage treatment plant functions including equipment supervision and control, alarm management, energy management, information management, and historical data collection and archiving. The automation system shall consist of the following:

1. Programmable Logic Controllers
2. Computer based SCADA

12.3 System Architecture

Processor: Controllers shall be microprocessor-based with a minimum word size of 32 bits and a maximum program scans rate preferably 2-3 msec but less than 1 second. They shall be multi-tasking, multi-user, and real-time digital control processors. Controller size and capability shall be sufficient to fully meet the requirements of this Specification.

Memory: Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control.

Hardware Real Time Clock: The controller shall have an integrated, hardware-based, real-time clock.

Communications Ports: The PLC shall provide at least one RS-232 serial data communication ports for operation of operator I/O devices, such as industry-standard printers, operator terminals, modems, and portable operator's terminals. PLC shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or terminals.

Diagnostics: Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The network controller shall

provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

Power Failure: In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.

Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence. Should a controller memory be lost for any reason, the operator workstation shall automatically reload the program without any intervention by the system operators.

PLC specifications

Point types: Each PLC panel shall support the following types of point inputs and outputs:

Analog inputs shall monitor the following analog signals:

- **4-20 mA Sensors**
- **0-10 VDC Sensors**
- **1000ohm RTDs**

Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

Analog outputs shall provide the following control outputs:

(iii) 4.20 mA - Sink or Source

(iv) 0-10 VDC

Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC.

Operator Interface - Personal computer operator interface

The automation system Contractor shall provide and install a personal computer workstation for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the network controllers to facilitate greater fault tolerance and reliability.

Workstation System Architecture - The architecture of the workstation shall be implemented to conform to industry standard APIs (application programming interfaces), so that it can accommodate applications provided by the automation system Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards. All historical information contained in Time Series Databases and all configuration data contained in relational databases must be accessed via ODBC (utilizing ANSI SQL database query specifications). All real-time, online plant data must be accessible by all applications (including, but not limited to, graphics, reports, etc.) via OPC (OLE for Process Control). All real-time event data (including alarms, change of state events, warning events, etc.) shall be accessible by all applications via OPC (OLE for Process Control). The Automation system Contractor shall provide all necessary OPC servers for communicating to the DDC controllers that are provided as part of this contract. In addition, the system shall accommodate installation and registration of OPC servers provided in the future by other equipment suppliers.

Workstation Operator Applications architecture: Major operator viewing applications shall be implemented utilizing the current Microsoft Model of an Active-X control, to be contained in one or more Active-X compliant containers. Specifically, the graphics application shall be provided as an Active-X control (for example it shall be possible to embed a graphic in a web page and view it in Internet Explorer). Conversely, it shall be possible to embed other Active X controls—such as trends and other third party available controls—in the real-time graphic application.

12.4 Operating System Software for PC

Windows 10 Professional (OEM)

Complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.

Peripheral Hardware

Alarm printers:

Printer Make : HP

Printing Method : Laser

Workstation Application Components:

Operator Interface

An integrated software package shall be used as the operator interface program. All Inputs, Outputs, Set points and all other parameters as defined or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software. The operator workstation software shall provide context-sensitive help menus and instructions for each operation and/or application currently being performed. All controller software operating parameters shall be displayed for the operator to view/modify from the operator workstation. These include set points, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

The operation of the control system shall be independent of the operator workstation, which shall be used for operator communications only. Systems that rely on the operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

Alarms:

Each workstation shall receive and process alarms sent to it by the control system. The alarm management portion of the operator workstation software shall, at the minimum, provide the following functions: Log date and time of alarm occurrence. Generate a “Pop-Up” window informing an operator that an alarm has been

received. Allows an operator, with the appropriate security level, to acknowledge, delete, or disable an alarm. Provide an audit trail for alarms by recording operator acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the operator, the alarm, the action taken on the alarm, and a time/date stamp. Record all alarms received at an operator's workstation to that workstation's hard drive. Allow the operators to view/manage the alarm data archived to hard disk. Selection of a single menu item or tool bar button shall allow the user to acknowledge, disable, delete, or print the selected alarm. Alarms shall be generated by the operator workstation for any controller that is "off-line" and is not communicating. Changes made to alarm set points from the Operator Workstation shall directly modify the controller alarm management database. Selection of a single menu item or tool bar button shall print any displayed alarm report on the system printer for use as a building management and diagnostics tool.

Reports

Reports shall be generated and directed to one of the following: workstation displays, printers, or disk. As a minimum, the system shall provide the following reports:

1. All points in the network.
2. All points in a specific controller.
3. A listing of a user-defined group of points in the network. There shall be no limit to the number of user-defined groups
4. All points currently in alarm.
5. All points in hardware override.
6. All disabled points.
7. All weekly schedules.
8. All or selected point attributes, including, but not limited to:
9. Values
10. Set points
11. Alarm Limits
12. Run Times

13. All programmed holidays and associated schedules.
14. All disabled alarms.
15. All active, unacknowledged alarms.
16. All active, acknowledged alarms.
17. Any and all other controller operating parameters.

The system shall allow for the creation of custom report point groups that shall be capable of including points from multiple controllers. Systems limiting point report displays to only a single controller's point database shall not be accepted. The number of custom reports or display groups shall be limited by the amount of available system memory. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report on the system printer for use as a building management and diagnostics tool. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display, and database manipulation capabilities as he or she deems appropriate for each user, based on an assigned password.

Each user shall have the following: a user name; a password, and an access level (from 1 - 5). The system shall allow each user to change his or her password at will. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor. A minimum of five levels of access shall be supported as follows:

- **Level 1 = Data Access and Display**
- **Level 2 = Level 1 and Operator Overrides**
- **Level 3 = Level 2 and Database Modification**
- **Level 4 = Level 3 and Database Generation**
- **Level 5 = All privileges, including Password Add/Modify**

A minimum of 100 unique passwords, including user initials, shall be supported.

Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on. User-definable,

automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving the operator workstation logged on. Within applications the user shall easily be able to navigate to new information (for example, launch a new graphic within a graphic).

Graphics

The graphics shall be able to display and provide animation based on real-time data that is acquired, calculated, or entered. Multiple graphic applications shall be able to execute at any one time on a single workstation. The Operator shall be able to configure the speed at which data will be updated on the specific graphic. Basic graphical objects: All graphics shall be able to be constructed from the following basic graphical objects:

Single or multi-segment lines of any thickness: Line styles at a minimum shall include: solid, dotted, and dashed.

Rectangles: User may fill with any color or no fill, and may configure the thickness of the outline.

Polygons: User may fill with any color or no fill, and may configure the thickness of the outline. Arcs.

Circles and Ellipses: User may fill with any color or no fill, and may configure the thickness of the outline.

Text boxes: User may configure text boxes with any W98 TrueType font, any foreground color, any background color, and with 8 or more thickness levels.

Animation: Any Basic object, any group of basic objects, or any symbol or group of symbols, shall be capable of being animated in the following manner:

Size: Any object's size shall be able to be animated based on the value of an analog variable.

Movement: Any object can be animated to move either in a straight line, or can follow a configured path of any number of line segments.

Rotation: Any object shall be able to be animated to rotate up 360 degrees.

Visibility: It shall be possible to make any object dynamically appear or disappear based on the true / false result of any boolean equations.

Operation from graphics: It shall be possible to change values (set points) and states in system controlled equipment by any of the following methods of operator interaction:

By selecting the object with either the left, middle, or right mouse button:

- Load a specific graphic.
- Drag/Drop to load a graphic in a selected window.
- Link forward or backward to another graphic.
- Change or toggle the value of an object.
- Launch an executable application.

Slider action: Any object can be defined to be a slider and configured to change a set point or other variables as the user slides an object over a configured geometry.

Dial action: Any object can be configured so that it can change a configured analog value over a range as the object is rotated. This is most often used to represent dials.

Data Entry: A variable is displayed on a graphic. By selecting the variable, the data entry function for the value is enabled and the operator is able to enter a new value for the variable.

Graphic editing tool: A graphic-editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing all drawing functions, defining all calculations to be executed as part of the graphic, defining all animations, and defining all runtime binding. It is not acceptable for separate programs to be required to do these various functions.

The graphic-editing tool shall in general provide for the creation and positioning of objects by dragging from tool bars and positioning where required. It shall provide the ability to create, at a minimum, all of the object types, all of the animation algorithms, and all of the action types referenced in this section.

In addition, the graphic editing tool shall be able to add additional content to any graphic by importing any Windows metafile (.wmf) or any bitmap file (.bmp).

Historical trending and data collection:

Each Network Controller shall store trend and point history data for all analog and digital inputs and outputs, as follows:

Any point, physical or calculated, may be designated for trending.

Each network controller shall have a dedicated RAM-based buffer for trend data, and shall store 96 samples for each physical point and software variable, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters. Trend and change of value data shall be stored within the controller and then uploaded to the trend database(s). Uploads shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format. To enable users to easily access stored data, the system shall provide the capability to store historical data in more than one file system (i.e., removable media, separate hard drives, or a remote network file system).

Trend data viewing and analysis.

Provide a trend viewing utility that shall have access to all database points.

Provide database access through an Open Database Connectivity (ODBC) interface - a standard Application Programming Interface (API) for accessing data from relational databases. Client applications can reside within a Windows 95, Windows 98, Windows NT or other latest windows environment. Graphic displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style. It shall be possible to display trend data in histogram (X-Y plots) format as well as area and bar graphs. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed. This function shall also be operator selectable. The display range shall consist of magnitude and units fields. The units are seconds, minutes, hours, days, and

months.

12.5 Instrumentation Design Criteria

The design criteria to be applied to instrumentation system shall be as follows:

- All instruments shall suitable for continuous operation.
- All transmitting instruments shall have a 4-20 mA/0-10VDC linear output.
- All digital outputs shall be volt free.
- Instruments shall be designed for the ambient conditions of temperature and humidity.
- All wetted parts of instrument sensors shall be non-corrosive and suitable for use with sewage.
- All instrumentation system for use out of doors shall be protected to IP 65.
- All analogue displays shall be of the digital type with no moving parts utilizing back lit liquid crystal diode LCD/ LED technology.
- Instrumentation shall utilize solid state electronic technology and avoid the use where practical of any moving parts.
- Minimum maintenance requirements.
- Instrumentation shall resume operation automatically on the application of power following a power failure.

Analogue instrumentation system shall be provided to monitor the following

- Raw Sewage Flow
- Sump levels
- Clogging of screens through differential level monitoring
- Total Power consumed by Plant.

Digital systems shall be provided as detailed in the Employer's Requirements and as necessary for the efficient and safe operation of the treatment plant. The Contractor shall provide plant to measure any other parameter required for the efficient and safe operation of the treatment plant. Instrumentation sensors shall be suitable for the environment in which they are expected to work. Sensor located

in hazardous (flammable) or potentially hazardous atmospheres shall be certified for use in these areas.

12.6 Flow Measurement

Flow metering as specified will be either open channel type or full bore Ultrasonic/electromagnetic type as applicable.

a. Open Channel Flow meter

The open channel flow meter should employ an ultrasonic principle to measure level and level to flow conversion should be inbuilt in the unit. It should provide isolated 4-20mA/0-10VDC outputs based on flow rate. It should have inbuilt LCD display and housed in an IP65 enclosure. It should have inbuilt temperature sensor for automatic compensation for changes in air temperature to ensure measurement accuracy. Maximum error in measurement should be within $\pm 0.2\%$ m at head change of 3m at 22degC and 40-70%RH. The probe unit should be in corrosive and unaffected by H₂S laden atmosphere.

b. Ultrasonic/Electromagnetic Flow meter

The electromagnetic flow meter should provide isolated 4-20mA/0-10VDC outputs based on flow rate. It should be housed in IP65 enclosure. It should have an accuracy of $\pm 0.5\%$ of flow rate at maximum mean velocity of 15m/sec. It should have a non-full pipe detection system inbuilt in it. The lining of material should be polyurethane with transducers. No rubber lining will be allowed.

12.7 Level Measurement

Ultrasonic level type measurement devices shall be used to monitor all tanks. They should be housed in an IP68 enclosure with a integrated display unit. It should have a 4-20mA/0-10VDC output based on level and a resolution of at least 1mm. Measuring range should be at least 0.3 to 8m. The unit should be CE /UL certified

12.8 Instrumentation Cables

All signal cables (Analog/Digital) shall be 660V, PVC insulated with stranded tinned copper conductors and laid up as twisted pairs with approximately one twist per 30mm approx. Each cable shall be overall screened of aluminium-mylar type

including drain wire giving coverage of 85%, and overall PVC sheath. The analog signals shall have conductors of .8 sq.mm. All external cables should be armored.

12.9 Control System Protection

Short Circuit

All power supplies to PLCs, instrument power supplies shall be protected against short circuit by the provision of adequate numbers of fuses or miniature circuit breakers.

12.10 Duty/ Standby Drives

The duty pump for each duty drive shall be selected on basis of minimum runtime and will be rotated for runtime equalization. The control logic shall automatically start an 'available' standby in the event of the duty drive failing.

12.11 Uninterruptible Power Supply (UPS)

Complete control instrumentation system should be powered through centralized UPS. The Network Controllers and Operator workstation should also be powered through online UPS.

Bidder shall provide true ON Line UPS system with rated working load plus 100% standby with parallel redundant in a room. The UPS system shall be provided with necessary by pass arrangement. Each UPS shall have minimum 30 minutes battery backup. The batteries shall be of maintenance free type.

All DC or AC voltage required for instrumentation system shall be derived within the control panels by providing a regulated DC power supply units or transformers. Generators of small capacity sufficient to feed UPS, shall be supplied and installed along with control gear, changeover scheme, exhaust and earthing.

12.12 Process Plant Control Philosophy

The control system in addition to providing the facilities detailed in the preceding clauses shall provide the following process plant specific requirements. The automation system should automatically on the restoration of power (following a power failure) start the plant operation sequence after expiry of delay timers and follow a startup sequence to prevent the simultaneous start up of various drives. The typical input/ output (I/O) requirements of various drives to

be controlled and monitored through DDCs are shown in Table 1.1.

12.13 Intercom System

An intercom system with 3x24 EAPBX shall be provided at all suitable locations especially between the following points within the treatment plant:

- Control room
- All rooms within the Administration and Control Building
- The pump and compressor room with the adjacent main distribution panel room
- The laboratory
- The disinfection house
- Duty Room
- Security Cabin at the entrance of the campus
- 132 KV GSS

TABLE 1.1: TYPICAL I/O SCHEDULE

Sl. No.	Items	DDC I/O, Controls and Alarm requirement					
		DI	DO	AI	AO	Controls	Alarms
1.	Tanks and associated Pumps						
	Tank Level(Through Ultrasonic level transmitter)			x		Level control	High and low
	Pump Start/Stop(2A rated potential free relay contact output)		x			Duty cycling on demand and runtime equalization. Standby to come online in case of duty failure	

Contractor

No. of correction

Executive Engineer

Sl. No.	Items	DDC I/O, Controls and Alarm requirement					
		DI	DO	AI	AO	Controls	Alarms
	Pump Status	x					Run
	Pump trip status(Through potential free contact of overload relay)	x					Trip alarm
	Pump auto manual switch status(Through auxiliary potential free contact of auto manual switch)	x					Manual mode
2.	All electrical drives (aerators, fans etc.)						
	Start/Stop(2A rated potential free relay contact output)		x			Duty cycling on demand & runtime equalization. Standby to come online in case of duty failure	
	Status(Through current relay)	x					Run
	Trip status(Through potential free contact of overload relay)	x					Trip alarm
	Auto manual switch status(Through auxiliary potential free contact of auto	x					Manual mode

Contractor

No. of correction

Executive Engineer

Sl. No.	Items	DDC I/O, Controls and Alarm requirement					
		DI	DO	AI	AO	Controls	Alarms
	manual switch)						
	Control sensors for automatic operation of the drives if required	x		x			High/low value alarm
3.	Power failure	x					Power failure alarm
4.	Power failure restart					Restart plant in sequence	Power failure restart mode ON

Notes:

- i. The I/O schedule detailed is indicative. The Contractor shall provide all the I/Os necessary in order to achieve the complete control and monitoring of the plant.
- ii. 15% spare for each type of digital and analogue I/Os shall be provided in each DDC.

INSPECTION, TESTING, ERECTION, COMMISSIONING & PERFORMANCE RUN OF MECHANICAL & ELECTRICAL EQUIPMENTS OF PLANT

1.1 General :

All equipments prior to dispatch for the site shall be tested at works as per relevant IS codes. International codes shall be used wherever Indian standards are not available.

1.1.1. Test Instruments:

The Contractor shall satisfy the Engineer as to the accuracy of all the instruments used for tests and if required shall produce recent calibration tests, or otherwise have them calibrated at his own expense by and independent authority.

1.1.2. Test Certificates:

Copies of certificates of all works, routine tests shall be provided as detailed.

The Contractor shall obtain and submit to the Engineer and to other parties as may be directed, certificates of test of all items, certifying that they have been satisfactorily tested and describing and giving full particulars of such tests.

1.1.3. Manufacturer's Works Inspection Tests and Guarantees:

All Schedules of Particulars shall be completed and the Guaranteed Particulars and the efficiencies of the equipment offered at the duties specified will be binding and may not be varied except with the consent in writing of the Engineer.

The Engineer shall be provided with the facility for inspection of all equipment and material and shall be given at least 10 days notice when such equipment and material is ready for inspection at manufacturer or vendors workshops.

Full witness testing to the relevant standards and to prove guarantees given will be required for the following items:

- i). All pumps for performance testing.
- ii). Electric motors for type on routine one motor of each size.
- iii). All control panels.
- iv). Chlorinator for relevant performance test.

v). All transformers for routine and type test on.

vi) EOT Crane as per relevant standards.

In addition all other items of equipment not subject to witness testing shall be temporarily erected at the manufacturer's works and tested for satisfactory operation and shall be offered for inspection. Copies of manufacturer's test readings shall be submitted to the Engineer, all prior to packing for shipment.

Such inspection, examination, or testing, shall not release the Contractor, manufacturer or supplier of any item from any obligation under the Contract.

Certified copies of manufacturer's test readings of all items shall be submitted to the Engineer within 7 days of the satisfactory completion of the tests.

Whilst the Engineer shall be provided with facilities for witness testing and / or inspection of all items of equipment at the manufacturer's works, he may at his discretion advise that the tests shall proceed in his absence. These tests shall be made as if in his presence, and duly certified copies of test readings shall be submitted.

Where items of equipment are of identical size and duty it may be required, at the Engineer's discretion, that a reduced number of the items be subjected to witness tests; however this shall not relieve the manufacturer from the requirement of carrying out the performance tests on all items prior to offering a witness testing.

If after inspecting, examining or testing any material or equipment, the Engineer shall decide that such items or any part thereof is defective, or not in accordance with the Specification or performances, he may reject the said items or part thereof, giving to the manufacturer within a reasonable time, notice in writing of such rejection, stating therein the ground upon which the said decision is based. All re-testing shall be at the Contractor's expense.

1.1.4. Site Testing:

The Contractor shall arrange for the full site testing of all items of equipment and shall include provision of:

a).	All skilled and qualified operating and test staff for the testing of all	
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equipment.

- b). Provision and disposal of all services, lubricants, and fuels other than electricity.
- c). All measuring and testing instruments to demonstrate equipment operates to the fulfillment of the works sheet.

1.1.5. Manufacture's Work Tests

1.1.5.1 Power Transformers

- i). Measurement of winding resistance.
- ii). Ratio polarity and phase relationship.
- iii). Impedance voltage.
- iv). Load losses.
- v). No-load losses and no-load current.
- vi). Insulation resistance.
- vii). Included over voltage withstand.
- viii). Separate source voltage withstand.

1.1.5.2 Type Tests

- i). Impulse voltage withstand both chopped and full wave.
- ii). Temperature rise.

Unless otherwise stated by the Engineer, evidence of type of tests carried out on identical transformers to those being provided under the contract will be accepted in lieu of actual tests.

1.1.5.3 Circuit Breakers And Control Gear:

- i). Routine tests including pressure test, milli-volt drop (Ductor) tests.
- ii). To ensure operation of the closing coil and satisfactory closing of the circuit breaker with the voltage on the coil down to 80% of its rated voltage, and that mal-operation does not occur with a voltage on the coil of 120% of its rated voltage.
- iii). To ensure the satisfactory trip operation of the circuit breaker at no load

conditions with the trip coil energized at 50% of its rated voltage.

- iv). Test figures for heat - run tests performed on identical panel types shall be made available.
- v). All interlocking, circuit breaker draws in & out operation.

1.1.5.4 Protection and Control Circuits:

Base on the completeness of the circuits in the final manufactured form within the manufacturer's works, the following tests shall be carried out:

- i). Primary injection tests to ensure correct operation of the current operated protection relays and direct acting coils over their full range of settings.
- ii). Balanced earth fault stability tests by primary current injection. Care must be taken to reproduce accurately the burdens of interconnecting cables. A further test to ensure correct polarity must be made after assembly. With different pilot wire schemes it may not be possible to apply primary injection testing. In this case the circuits shall be proved by secondary injection. Current transformer characteristics and calculations associated with the above tests shall be available for inspection by the Engineer.
- iv) Correct operation of control circuits at normal operating voltage by operating voltage by operation of local control switches, and simulation of operation from remote control positions.

1.1.5.5 Motors:

Motors over 100 KW site rating shall be subject to full performance tests which may be witnessed by the Engineer at the Motor manufacturer's works. Motors of 5.5 KW to 22 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 which shall include the following shall be provided for all motors :

- i). Manufacture to BS.
- ii). Class of Insulation.

- iii). Type of cable fittings.
- iv). Type of bearing sizes and lubricant.
- v). Type and rating of motor heaters.

Motor testing shall be carried out in accordance with the requirements of BS 4999.

1.1.5.6 Instruments And Meters:

Tests to ensure operation of all ammeters, voltmeters and transducers and checks for correct calibration KWH meters shall be checked for correct rotation and creep tests shall be carried out to ensure that the meter is inoperative with voltage along, if the secondary of the current transformer is left connected with the primary current interrupted.

1.1.6. Tests On Cables During Manufacture:

All cables supplied under the Contract shall be subject to routine tests in accordance with the relevant British Standard. Cables will not be accepted on Site for installation until certificates giving proof of compliance with the Specification and date of tests have been received and approved by the Engineer. A certificate shall be applicable to each drum.

The tests to be carried out on every drum at manufacturer's premises shall include:

- a). High voltage A.C insulation pressure test between cores, each core to earth metallic sheath or armour as applicable.
- b). Insulation resistance test.
- c). Core continuity and identification.
- d). Conductor resistance test.

1.1.7. Process Control and Indicating Instruments:

All flow, level and process measurement controllers, transmitters, recorders, indicators, vacuum and pressure gauges shall be subject to routine in accordance with BS 88, BS 1780 and BS 3680.

Test Certificates shall be provided against each item of equipment.

1.1.8. Electrical Measuring Instruments and Meters:

Tests to ensure accurate operation of all meters, voltmeters and kwh meters shall

be undertaken in accordance with BS 89 and BS 37.

1.1.9. Alarm Systems:

The Contractor shall be responsible for testing all items of equipment comprising the Works alarm system for correct operation and sequence action.

1.1.10. Site Tests:

Leakage Tests at the test pressure shall be carried out on all erected pipe work and valves immediately after erection and before being built in. The Contractor shall advise the Engineer when these tests are to be carried out.

9.1.11. Tests on Cable During Installation:

During the period of site installation the Engineer will carry out inspection of the Works to ensure the standards of workmanship meet the specification and are to his satisfaction. In the event of any part of the cabling installation failing to meet these requirements the Contractor shall remedy the deficiency to the satisfaction of the Engineer.

After completion of various parts of the installation the Contractor shall provide a test engineer, labour and materials to demonstrate to the Engineer that the cables have been correctly installed.

The Contractor shall inform the Engineer prior to the testing of cables and shall be responsible for liaison with any other contractor to whose equipment the cables may be terminated to ensure all parties concerned are aware of the impending tests, to guarantee safety of personnel and that isolation of any particular equipment has been completed. Any special isolation or preparation required to be carried out before cable testing will be completed by the Contractor responsible for that equipment. All tests shall be carried out by the Contractor to the satisfaction of the Engineer.

1.1.12 Pumps Sets:

Tenderers shall complete the Schedule of Particulars and Guarantees and shall

state therein, inter alia, the guaranteed efficiencies of the pumps and motors offered, and the overall guaranteed rates of energy consumption of the complete pump sets at the duties specified. The contractor's guarantees given when tendering in respect both of performance and efficiency shall be binding and considered part of the contract. The fulfillment of these guarantees shall be verified at the test works to be witnessed by Employer and at Site trials in accordance with the procedure given in British Standards 5316 and 4999 etc. These site trials shall be carried out under the control of the contractor's staff to the satisfaction of the Engineer. The Contractor shall provide all the necessary labor and instrumentation to conduct the tests. The discharge from the pumps shall be measured wherever possible by the volume drawn from a sump or delivered to a tank over timed intervals.

1.1.13 Electrical Plant:

After all the deficiencies apparent during the installation inspection have been rectified to the Engineer's satisfaction, the following tests shall be carried out.

1.1.13.1 Circuit Breakers and Control Gear:

Routine tests, including H.V. pressure tests.

1.1.13.2 Protection And Control Circuits:

Tests at 1.5.4 with the addition of satisfactory operation of all inter-tripping circuits in conjunction with other items of plant.

1.1.13.3 Tests on Cables after Installation:

Every cable shall be subject to the following tests after installation:

High voltage pressure tests:

The following D.C. test voltages shall be applied at full valve.

- i) PLYSWS 11,000 volt grade cable

Between cores 30,000 volts between any core and armour 17,500

Volts.

- ii) XLPESWAPVCC 3,300 volt grade cables.
Between cores 10,000V Between any core and armour 5,800 V
- iii) XLPESWAPVC OR
PVCSWAPVC 1,100 volt grade mains cable
Between cores 3,000 V Between any core and armour 3,000V

Witnessed high voltage pressure tests shall not be carried out on PVCSWAPVC 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' 5000 volt hand generator. The Contractor shall test all cables after installation to ensure correct phasing out of cores, continuity of cores sheath and armour over the whole length of the cable.

1.1.14. 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 and IS 3043. 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. The each earthing station shall be separately tested and value of earthing resistance shall be displaced under man hole cover.

1.1.15. Installation Inspection:

In additional to the progressive supervision and inspection by Employer the Contractor shall offer for inspection to Engineer, the completely created plant/ part of plant on which tests are to be carried out. After such inspection by Engineer, each equipment / sub system shall be tested by the contractor in accordance with the applicable standards in the presence of Engineer. Such tests shall include but not be limited to the tests specified in following clauses.

1.1.16. Pre-commissioning Trials, Tests Of Electrical Equipments.

1.1.16.1 Start Up:

On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Engineer

and the Contractor for correctness, completeness of installation and acceptability for start-up, leading to initial pre-commissioning tests at site. The list of pre-commissioning tests to be performed shall be as mutually agreed by the Engineer and Contractor.

1.1.16.2 Initial Operation (Initial Run)

After the pre-commissioning tests are satisfactorily over, the complete plant shall be placed on Initial Operation during which period the complete equipment shall be operated integral with sub-systems and supporting equipments as a complete plant and necessary adjustments made while operating over the full load range enabling the plant to be made ready for commissioning. The period of Initial Operation shall be as mutually agreed by the Engineer and the Contractor. An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during Initial Operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Engineer to enable him to accord permission to carry out the commissioning the conduct. Performance and Guarantee Tests on the Plant. However, minor defects which do not endanger the safe operation of the equipment shall not be considered as reasons for withholding the aforesaid permission. The cost of all labour, energy and consumables other than water required for Pre-commissioning, Initial Operation shall be borne by the Contractor. Water required for running the plant will be supplied free by the Employer.

1.1.17. Commissioning:

The plant shall then be commissioned and put on Trial Operation at full load when Performance Guarantee Tests shall be conducted.

During the period of trial operation the Contractor shall

- i). Operate the full works on behalf of the Employer.
- ii). Supply the labour and materials including consumable required for the operation and maintenance of the works and bear the cost of electrical energy.
- iii). Instruct the Employer's operators in the operation and maintenance of the work; a programme shall be submitted by the Contractor for the training of operators, both supervisory and subordinate levels. This program shall be submitted to the Engineer three months before the scheduled start of commissioning. The training of the employer's staff shall be carried out with reference to the operation and maintenance manual furnished by the Contractor.
- iv). Carry out maintenance repairs of defects immediately.
- v). During the period of trial operation of working hours of the Contractors shall be 24 hours daily, 7 days week.

The Contractor shall provide for the expenditure on all the consumables any energy required during the trial operation. All labour and cost of any other materials shall also be met fully by the Contractor. Water for operating the Plant will be supplied free by the Employer. The Trial Operation shall be considered successful, provided that each item of the equipment can operate continuously at the specified characteristics, for the period of Trial Operation and the Performance Guarantees are successfully met. Any special equipment, tools and tackles required for the successful completion of the Performance and Guarantee Tests shall be provided by the Contractor free of cost. The guaranteed performance figures of the equipments shall be provided by the Contractor during the Performance and Guarantee tests. Should the results of these tests show any decrease from the guaranteed values, the Contractor shall modify the equipments as required to enable them to meet the guarantees? In such case, Performance and Guarantee Tests shall be repeated within one month from the date the equipment is ready for re-test and costs for modifications including labour, materials and the cost of additional testing to prove that the equipment meets the guarantees, shall be borne by the Contractor. Performance and Guarantee Tests shall make allowance for instrumentation errors as may be.

1.1.18. Completion

- a) The Works will be certified as virtually completed by the Employer only after it has successfully completed trial operation for a continuous period of three months.
- b) A Virtual Completion Certificate for plant shall not be issued unless the following documentation are duly compiled and submitted in final formats in duly bound volumes.
 - i) A Completion of all shop inspection results/ reports of the plant/machinery with due attestation that the plants have been manufactured to specified standards (6 copies)
 - ii) All erection/construction quality control checks in appropriate approved formats for installation works with attestation that installation has been carried out as per acceptable / stipulated standards (6 copies)

1.2 Start Up and Performance Run

1.2.1 Tests on Completion:

1.2.1.1 General

Prior to the commencement of Tests on Completion the Contractor shall submit the following:

- Site Acceptance Test Documents
- As built drawings
- Operation & Maintenance Manuals

Test on completion shall not be commenced until the aforementioned documents are approved.

The initial charges necessary for Tests on Completion shall be provided by the contractor. Electricity required for Tests on Completion will be provided by Employer free of charge for a period not exceeding 30 days. In case the test on completion period exceeds 30 days, the cost of power till start of performance run shall be borne by the contractor. The cost of any consumables and chemicals required for the tests on shall be borne by the contractor.

1.2.1.2 Dry Test Requirements

1.2.1.2.1 General

As a minimum requirement, the following dry tests shall be carried out as a general requirement:

- A general inspection to check for correct assembly and quality of workmanship
- A check on adequacy and security of Plant fixing arrangements
- A general check to ensure that all covers, access ladders, water-proofing, guard railings etc. are in place,
- A check on damp proofing, rust proofing and vermin proofing and particularly the sealing of aperture between building structure, chambers, etc. and the outside.

1.2.1.2.2 Civil and Building Works

As a minimum requirement the following dry tests shall be carried out on the civil engineering and building works:

- Check for the presence of foreign bodies in pipe work and structures.

1.2.1.2.3 Mechanical Works

As a minimum requirement the following dry tests shall be carried out on the mechanical systems:

- Carry out preliminary running checks as far is permitted by circumstances in order to ensure smooth operation of Plant.

1.2.1.2.4 Electrical Works

As a minimum requirement the following dry tests shall be carried out on the electrical systems:

- Check phasing and polarity
- Carry out point to point check on all cables
- Check on security of cable terminations
- Check on completeness and adequacy of earthing systems;
- Check setting on protection relays, sizes of fuses and motor overload

- Carry out checks on cabling systems in accordance with the requirements the relevant standards
- Check operation of main circuit breakers by secondary injection methods
- Check rotational direction of drives.
- Check instrument loop integrity, functionality and calibration;
- Check operation of standby generator installation and mains/generator changeover procedures; a 4 hrs load test (using the normal load| Works) shall be carried out on the generator when the load is available
- Check plant functionality

1.2.1.3 Process Plants/Equipments

All process plant items/equipments shall be tested to ensure that they meet the Employer's Requirements for quality of workmanship, construction and performance.

1.2.1.4 Hydraulic Wet Test Requirement

Hydraulic wet tests shall be carried out on completion of dry tests. Potable water shall be used for hydraulic wet tests. The purposes of the 1 to prove as far as is practical the hydraulic performance of the Works. In order to demonstrate this Contractor shall ensure that each part of the Works is hydraulically loaded to its maximum rated load throughout for a period of at least seven days at twenty-four hours intervals. In order to ensure a sufficient supply of potable water to carry out these the Contractor shall provide facilities for the disposal off site in an approved manner. In order to remove doubt the following tests inter-alia shall be carried out.

- Pressure testing of all piped systems laid direct in ground in accordance to the relevant standards;
- Fill all structures and check for leaks as per IS: 3370;
- Running of all pumped systems in order to check for
 - Correct functionality
 - Absence of leaks
 - Correct running temperatures
 - Smoothness of running and the absence of undue vibration or stress

- Check drive running currents
- Carry out calibration of instruments where appropriate
- Carry out valving, diversion etc. to fully hydraulically load each element (or where there is a requirement to withstand an over overload each process element;
- Demonstrate correct functionality of electrical, control and instrumentation systems. The Contractor shall simulate where practical the conditions that will when operating as a process in order to demonstrate the correct functions process control loop etc. During these tests a check on the performance of Plant shall be made, as far as site facilities will allow, to compare its site performance with the factory test data and to identify and constraints on performance due to site conditions.

1.2.1.5 Process Wet Test

On approval by the Employer the Contractor shall carry out process wet tests. Raw water shall be used as the primary feed stock for process wet tests. These tests shall be carried out to demonstrate the process performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is located to its rated throughput (including a period of overload if required in order to demonstrate compliance with the Employer's Requirements) for continuous stable operating period of not less than 48 hours. The Contractor shall provide facilities for the disposal off site in an approved manner.

The following tests inter alia shall be carried out;

- Check and rectify leakage on civil structures, pumps and pipe work;
- Running of all pumped systems in order to check for;
 - Correct functionality,
 - Absence of leaks,
 - Correct running temperatures,
 - Smoothness of running and the absence of undue vibration or stress,
 - Check drive running currents where the solution pumped is different from that pumped during hydraulic wet tests;

- Carry out calibration of instruments;
- Carry out valving, diversion etc to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element;
- Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing. On completion of process wet test on the various parts of the works the Contractor shall run the plant as a whole in order to demonstrate the full functionality and performance of the Works at various throughput rates for a continuous period of not less than 7 days. This shall be considered as completion of 'Test on Completion' and shall be certified by Employer.

1.2.2 Performance Run After Start Up

1.2.2.1 General

On successful completion of 'Test on Completion' i.e. start up and commissioning, certified by Employer, Contractor should start the performance run of the plant for 1 month. During performance run period, the Contractor shall provide following as minimum for round the clock operation.

DESCRIPTION OF STAFFING

Sr. Personnel	No.	Total Experience	Main Task of the Personnel
1 Plant In Charge (BE Civil/Environment)	1	5 years	Coordination of activities for satisfactory performance of the STP & pumping station and reporting to the Engineer-in-charge and responsible for the proper functioning & maintenance, data collection of STP & pumping station.
2 Operators (Diploma, ITI Qualified)	6	3 years	Responsible for overall operation for STP and pumping station.
4 Electrician (ITI Qualified)	1	3 years	Responsible for maintenance of electrical equipment.
5 Fitter (Mech.) (Diploma, ITI Qualified)	1	3 years	Responsible for maintenance of mechanical equipment.
6 Helpers	6	1 years	Responsible for keeping the STP premises clean and neat. Also they will assist operators in day to day activities.
6 Security Guards	4	1 year	To protect the plant from the trespassers,
Contractor	No. of correction		Executive Engineer

animals etc.

7 Gardener	1	5 years	To maintain the garden/landscaping of the plant
8 Sweeper	1	5 years	Assisting in day to day activities in office, keeping office clean & neat.

Spares: As required for replacement during performance run period. The spares used from the spare supplied under the contract shall be rep the Contractor. Employer shall supply power and water during Performance Run period free of cost. All other material such as chemicals, consumables, lubricants, tools & plant spares etc. shall be provided by the contractor. The contractor, if required shall provide activated sludge or any other material for the stabilisation of the plant.

The Contractor shall provide operators for various units/plants for three shifts and other staff/supporting personnel in general shift. The Contractor shall submit a weekly report to the Employer, about the operation and maintenance indicating the manpower, electric power, chemicals consumables consumed and also problems faced and rectified. During this period, the Contractor shall ensure that the design treated quality standards are met in accordance with the specification within the rate of power and chemical consumption as committed by the Contractor. The treated sewage analysis pH, SS, BOD and oil & grease shall be carried out on daily basis from the day of commissioning at a reputed laboratory as approved by Engineer-in-Charge. 90% of the treated sewage samples should fall within prescribed limits of the treated sewage. The sampling location for raw shall be at raw sewage sump and that of treated sewage shall be at chlorine contact tank.

The analysis of sewage for the above parameters at different locations outlet of SBR Process basin shall also be carried out on weekly basis Contractor shall take immediate steps to correct the operation of the meet the guaranteed performance. The charges for analysis at the laboratory to be borne by the Contractor.

The Contractor's responsibility includes the safety and security works/plants during the course of performance run of three month.

1.2.3 Performance Run Certificate

The conditions for issuance of a Performance Run Certificate as detailed in the Conditions of Contract shall comprise:

- The completion of the three months operation and maintenance under performance run of the treatment plant to the satisfaction of Employer.
- 90% of treated sewage samples fall within the prescribed limits of the treated sewage mentioned in the tender-document
- The Operation & Maintenance Manual have been updated following three month's operational experience and approved by Employer.
- All defects during the three months operation of the works have been rectified.

Employer shall issue a Completion Certificate for "Performance Run of Plant" after successful completion of Performance Run of plant for 90 consecutive days by contractor to the satisfaction of Employer.

APPROVED MAKES**19. 1 CIVIL ITEMS**

SL. NO.	MATERIAL, WORK	SUPPLIER, MANUFACTURER, VENDOR, AGENCY
1	Cement (OPC) 43 Grade / 53 Grade	Ultratech, ACC, Birla Gold
2	Cement (SRC)	ACC, Gujrat Sidhee, Gujrat Ambuja
3	Cement (White)	Birla, JK
4	Cement (PPC)	ACC, Gujrat Sidhee
5	Bricks	Ordinary Burnt Clay Bricks of any brand conforming to IS: 1877 with minimum Crushing Strength of 40 Kg/cm ² and Water Absorption Ratio restricted to 25% for Bricks used in Panel Walls and 20% for Bricks used in Load Bearing Walls
6	Mild, Tor Steel, CRS Steel	Integrated plant
7	Structural Steel	SAIL, TISCO, Vizag
8	Screws	GKW Nattlefold, Oxidised
9	Dash Bolt Fasteners	Fischer, Hilti
10	Ceramic Tiles	Spartex, Kajaria, Nitco, Johnsons, Somany, Pedder
11	Glazed Tiles (1 st Quality)	H & R Johnson, Kajaria, Spartex, Naveen, Rommano, Somani Pilkington, ECL
12	Granite Tiles	Bell Granito, Naveen, H & R Johnson, RAK Ceramics - Dubai, Restile Ceramic
13	Glass Mosaic Tiles	Bisazza India, Pino Bisazza
14	Paver Blocks	Conwood Prefab, Hindustan Prefab or equivalent
15	Adhesives	Pidilite, Fairmate, Bal Adhesive, MC Bauchemie, Cementone India, Fosrock,

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		Sunanda Speciality Coating
16	MS Door Frames & Shutters (With Galvanising)	Agew, Ferrosteel, Sen Harvic, Weldoors, Yashashri Polyextrusion
17	Door Shutters (Wooden)	Kutty, Anchor, Classic, Goyal, Timber Techniks, Sejpai Doors, Wood Designs, Yashashri Polyextrusion, Anand Wood Crafts, Northern Doors
18	Door Shutters (FRP) & Plastic	Everest fibre glass Industries, Unipals India, Advance Marketing, Yashashri Polyextrusion, Sintex
19	Hardware (Handles, Hinges, Mortice Locks)	Shalimar, Sobeet, Vijayan, Navbharat Brass Works, CIEF, Amarbhoy Dossaji
20	Aluminium Windows	Aluminite, Aluplex, Almech, Indrajit Associates, Aldoweit, Crystal Corporation, Indal, Jindal, Ajit India
21	Night Latch	Godrej, Sobeet, Vijayan, Yale
22	Paints:	
	a. Internal	Snowcem, Asian, ICI, British Paints, Shalimar, Nerolac, Burger, Jenson & Nicholson
	b. External	NITCO Paints, Killick Nixon, Hindustan Colours and Chemicals, Supreme, Shalimar, Burger, Jenson & Nicholson, Super Snowcem.
23	Synthetic Plaster Finish	Nitco, Accro, Damani Dye Stuff, Supreme, Renova
24	Waterproofing Works	India Waterproofing Co., Likproof India, Overseas Waterproofing Co.
25	Waterproofing Compound	Accoproof, Pediproof, CICO, Impermo, Vamiplas 302, Vamiproof 101 & 102
26	Glazing	Float Glass of Modi , Asahi , Saint Gobain

Contractor

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Executive Engineer

27	M.S. Rolling Shutters (With Galvanising)	Swastik, Standard, Shudwar
28	Aluminium Grills	DECO, Alumnigrille
29	Aluminium Joinery	Crystel Corporation, Alumlite, Aluplex, Alm
30	Anti-stripping Agent	Yuva, BE 100
31	Chemical Admixtures and Compounds for RCC and Mortar	MC Bauchemie, Krishna Conchem Products, Sunanda Chemicals, Pidilite, Fairmate, Fosroc, Sika Qualcrete
32	Anti-Corrosive Paint	Krishna Conchem Products, CICO Chemisol Adhesive, Shalimar, Burger
33	Sanitary ware	Hindustan, Parry, Cera, John Gas, Jotisum
34	Flushing Cistern	Flush Line or equivalent Approved ISI Manufacturers
35	Sanitary Fittings and Fixtures	Mark, Jaguar, Gem, Dripless, Kingston, Essco, Metro, Ess Ess
36	Lead for Lead Joints	Approved ISI Manufacturers
37	Rubber Ring	Approved ISI Manufacturers
38	Stainless Steel Sink	Nirali, Tuff, Diamond, Kingston, Neel Kamal
39	SW Gully Trap and Stone ware Pipes	Perfect, Sonya, Girco, Elecon, Rajura
40	Cast Iron Covers	RIFCO, Mohit Steel, Ashok Iron Works, Jayswal Neco
41	Piling Works	Kvaerner, Afcons, Michigan Engineering, Larsen & Toubro, DBM Geotechnics, Meher Foundations, Safe Foundations, Simplex
42	Fire-fighting Works	Monsher, Mather & Platt, Bells Controls, Nitin Fire, Rahul Fire
43	Elevators	Otis, Mitsubishi, Kone, Bharat Bijlee,

Contractor

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Executive Engineer

		Schindler
44	Sodium Nitrate	Devica Chemicals or equivalent Approved ISI Manufacturers
45	Sodium Silicate	Devica Chemicals or equivalent Approved ISI Manufacturers
46	Marine Plywood	Anchor, Kitply
47	Neeru	Swastic Instant Neeru or equivalent Approved ISI Manufacturers
48	Lime for Whitewash	As directed by Engineer-in-charge
49	Tarfelt	Shalimar, Lloyds
50	Lightening Conductor	Approved ISI Manufacturers
51	Teak Wood	C.P. Teakwood, First Quality with following Tolerances. Sap Wood to the extent of 25% Wrap to the extent of 10 mm in 3m Knots/meter
52	S.W. Pipes	Burn & Co., Perfect Potteries, Navroji Vakil, Kashimira
53	CI Soil Pipes & Fittings as per IS : 3989/84	NECO, CENTRI
54	G.I. Pipes Class "C"	TATA, Zenith, Jindal, Suryaprakash
55	G.I. Fittings	Approved ISI Manufacturers
56	Gate Valve / Non Return Valve	Sant, Zoloto, Leader
57	S.W. Pipes	Rajura or other Approved ISI Manufacturers
58	Flush Valve	Jaguar , Ess Ess
59	Water Meter	Capstan or other Approved ISI Manufacturers

20. 2 ELECTRICAL ITEMS

SL.	MATERIAL, WORK	SUPPLIER, MANUFACTURER, VENDOR,
Contractor	No. of correction	Executive Engineer

NO.		AGENCY
1	S.F.U., Breakers	L&T, Siemens, GE, Schneider
2	Distribution Boards	MDS, Siemens, Schneider, Hager
3	Indicating Digital Meters	AE, Meco, L&T, Konzerv
4	Crimping Lugs, Glands of Double Compression Type	Dowells, Jainson, Lotus, Braco
5	Jelly filled Telephone Cables	Finolex, Universal, RPG
6	Tag Block with Boxes	Krone
7	Rossets	ITL, Tele Connectors India
8	MCB, RCCB	MDS, Siemens, Schneider, Hager
9	Main L.T Panels, PDB, LDB	Incorporating L&T, Siemens, GEC, Schneider Switchgear Components
10	Switches and Sockets	MDS (Leagrand), Schneider, Anchor, Cona, ROMA
11	PVC Copper Wires (FRLS Grade)	Finolex, RR Kabel, Polycab
12	Motors	Siemens, ABB, Crompton, Kirloskar, Alstom
13	Cable Glands and Lugs	Dowell, Lotus, A.G. Electricals, Siemens
14	Cat-6 Lan Wire	Lucent, LAPP, AMP
15	PVC Pipe	Diamond, Precision (PPI), Asian
16	Lighting Fixtures	Wipro, Phillips, Crompton, Bajaj, Havells
17	Fans & Air-Circulators	Crompton, Bajaj, Almonard, Usha, Orient, Khaitan
18	Distribution Transformer 11 KV, 433V	Crompton, Kirloskar, Voltas, Pactil, Voltamp
19	11 KV VCB Breaker & Panel	ABB, Schneider, Siemens, Alstom, Jyoti, Kirloskar, Crompton
20	Relays	ABB, Siemens, Alstom (AREVA), Schneider, L&T
21	11 KV SF6, Insulated 3-Panel, 4-Panel extensible type RMU	Crompton, ABB, Siemens, Alstom, Schneider, L&T

Contractor

No. of correction

Executive Engineer

22	ACB 8-Way, Feeder Pillar 6-Way, 4 Way & Mini Pillars	Popular Brass Metal Works, ABAK, Manish, Fitwell, Super Panel, Control & Switchgear, Chavare Engineering Pvt. Ltd.
23	Fuse Base	Siemens, L & T
24	Control Cables	Polycab, Finolex, KEI
25	Batteries	Amaron, Exide
26	11 KV End Termination & Straight through Joint	Raychem, Xicon, Danson, CCI
27	Measuring Instruments	MECO, IMP, Rishiline (L&T), Conzerv
28	PVC Insulated Cable for Working Voltage up to 1.1 KV as per IS: 694: 1990	Finolex, Polycab, CCI
29	XLPE - LT Cables as per IS:7098 Part - I: 1988	CCI, Finolex, Polycab
30	XLPE - HT Cables as per IS:7098 Part II - 1985	CCI, Finolex, Polycab
31	PVC Insulated (HD) Cable up to 1.1 KV as per IS:1554 Part I - 1988	CCI, Finolex, Polycab
32	Air Conditioners	Samsung, LG, Voltas, Carrier
33	Lamps HPMV,HPSV Metal Hallide Lamps & Accessories	Crompton, Havells, Bajaj, Philips
34	MCB,ELCB,RCCB,HRC	L&T, MDS,Siemens, ABB
35	T. W. Boards & Blocks	Double Folding Polished Board shall be in one Piece. Block up to 8" x 10" shall be in two Pieces
36	T. Switch S.P. or 2-Way S.A. to I.S.A.	Khosla, Keycee, GNE, Modern, Kalki
37	Three Pin Socket: 5A to 15A	Khosla, Keycee, Standard, Ellora
38	Ceiling Rose	Khosla, Keycee, Ellora, Oshan, Modern
39	Ring Main Unit, HT, Switch and	L&T, Siemens, ABB, Crompton, MEI

Contractor

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Executive Engineer

	Fuse Unit	
40	C.T. / P.T.	ABB, Kappa, AE
41	Auto Transformer Starter	MEI, Kilburn, JMP, Siemens, Andrew Yule, GEC, KEC
42	Trivector Meter	Department approved / MSEDCL approved
43	Measuring Instrument	IMP, AE, MECO, Rishiline (L&T), Konzerv
44	Current Transformer	AE, Gilbert & Maxwell, IMP, Siemens, SEGC (C.S.), VM Electric or Department approved
45	PVC Conduits, PVC Pipes, HDPE Pipes	Garware, Finolex, Prince
46	GOD Switches and Dropout Fuse Outfit	Kiran, Pactil, Atlas or Department approved
47	Chain Pulley Block	Elephants, Hercules, Morris
48	Lugs	Dowels, Lotus, AG Electricals
49	Motor Protection Relays	Universal, Thresold, E.E., L&T, Minilac, Siemens, C&S. Telemechanique, Indo-Asian
50	Feeder Pillar, Mini Pillar	Popular Brass Metal Works, Anil Electrical Industries or Department approved
51	MCB & MCB, D.B.	MDS, Siemens, EE, Telemechanique, Havells, Schneider
52	ELCB	Datar, MDS, Standard, GE, Telemechanique, Havells, Schneider
53	PVC Wires, Copper Aluminium Conductor, Flexible Cables	Finolex, Polycab, KEI
54	HRC Fuses	L&T, Siemens, Havells
55	Fuse Switches, SW Fuse	L&T, Siemens, Crompton, Telemechanique, Havells, Schneider
56	Switches, Sockets	Kalki, CPL, Anchor, Precision
57	Cable Glands	HME, EEW, Konzerv & Department

Contractor

No. of correction

Executive Engineer

		approved,
58	HC Fuse Distribution Board	CPL, EE, Ess Ess, Stenly, KEW, Kalki, Standard
59	Air, Oil Circuit Breakers (HT,LT)	Siemens, L&T, Crompton, ABB
60	Energy Meters	L&T, Enercon, Simco, IMP
61	Capacitors	Crompton, L&T, Schneider, EPCOS, (S+M)
62	Steel Tubular Poles	Indian Electric Poles, Bombay Tubes, Nityanand, Rajan Tubes or approved ISI Manufacturers
63	GI Pipes, Poles	Zenith, Tata, Bharat, Jindal, Suryaprakash
64	Terminal Box, Bracket, Junction Box, Control Pillar	ELM, United, DVK or Department approved
65	Street Lighting Luminaries	Bajaj, Crompton, Philips, Wipro, Havells
66	Chokes, Ignitors	Bajaj, Crompton, Philips
67	Power Contactors	L&T, Siemens, Crompton, ABB
68	Lamps	Bajaj, Crompton, Philips, Surya
69	Rotary Selector Switches	L&T, Siemens, Kaycee, EE, BISOONS (ELM), Schneider
70	Post Top Lantern	Philips, Crompton, Glolite, Bajaj, Wipro
71	Street Light Controller, Timer	L&T, (TSQ 100) 24 hrs. Dial, ELM, GIC
72	ASCR Conductors	As per MSEDCL approved
73	Alternators	Kirloskar, Caterpillar, Stamford, CG Newage
74	Diesel Engines	Kirloskar, Greaves Cotton, Cummins, Cater Piller, Powerica
75	Cable Jointing Kit	Raychem, Xicon, Benson, Mahindra (Push on) M Seal
76	Pole Paint	Jenson & Nicholson, Asian (S+M), Nerolac
77	Fluorescent Fixtures	Bajaj, Crompton, Philips, GEC, Wipro
78	Analyzers	Forbes Marshall, Endress& Hauser
79	Level Switch, Level Indicator	Forbes Marshall, Endress& Hauser

Contractor

No. of correction

Executive Engineer

80	Flow Meter - Magnetic, Ultrasonic	Forbes Marshall, Endress& Hauser
81	Soft Starters	Allen Bradly, Schneider, Innovative Tecno
82	Motors	Crompton, ABB, Siemens, Kirloskar
83	Electrical Panels	Interlec, Positronocs, Jay Switchgear, Chavare Engineering, L&T, Siemens, ABB, Schneider, Crompton, Spark Electro

21.

22.

23. **3 ELETROMECHANICAL & INSTRUMENTATION WORK**

SL. NO.	MATERIAL, WORK	SUPPLIER, MANUFACTURER, VENDOR, AGENCY
1	Mechanical Screens- Coarse & Fine	Jash, Johnson, Huber
2	Detritus Mechanism	Voltas, Emco, Geomiller, Shivpad
3	Pumps: Horizontal Centrifugal	Kirloskar, KSB, Grundfos, Mather & Platt, Jyoti
4	Pumps: Submersible	Kishor, Kirloskar, KSB, Grundfos, Aqua, Mather & Platt, Wilo
5	Pumps: Vertical Turbine	Kirloskar Brothers Limited, WPIL, Mather & Platt, Jyoti, Homa, Flowmore
6	Pumps: Screw (Positive Displace / Progressive Cavity Type)	Roto, Flosys, Tushaco, Netzsch
7	Pumps: Chemical Dosing (Positive Displacement Type)	Milton Roy, Shapotools, Roto, Positive Metering Pump
8	Air Blowers	Kay International, Swam, Everest, KPT
10	Air Compressor	Ingersoll Rand, Elgi
11	Fine Bubble Membrane Diffusers	EDI, OTT, Rehau
12	Chlorinators	Metito, Pennwalt, Sumitra, RR

Contractor

No. of correction

Executive Engineer

		Enterprises
13	Submersible Mixers	ABS, Grundfos, ATE, WILO
14	Agitators	Dorr-Oliver, Voltas, Fibre & Fibre, Standard Engineers, Shivpad
15	Centrifuges	Alfa Laval, Hiller, Humbolt, Pennwalt
16	Chain Pulley Block, Electrical Hoist, JIB Crane	Elephant, Hercules, Indef, Brady & Morris
17	Pipes:	
	MS / GI Pipes	Tata, Zenith, Indus tubes, Swastic, Jindal
	SS Pipes	Jindal, Lloyds, Zenith, Remi, Prakash
	CI Pipes	Kesoram, ISSCO, RIFKO,SRIF, Electrosteel, Electrotherm
	DI Pipes	Electrosteel, Lanco, Jindal
	PVC Pipes	Prince, Supreme, Reliance, Premium, Kissan, Garware
	UPVC Pipes	George Fisher, Astral
	HDPE Pipes	Hallmark, Vijay, Sangir, Sriram Polymers
	RCC Pipes	Indian Hume Pipes, Premier Prestressed Concrete Product, Patel Hume Pipes
18	Sluice Gate	Voltas, Jash, IVC, Durga
19	Valves: Butterfly, Non-Return, Knife Gate, Gate, Ball, Globe, Diaphragm, Plug	IVC, Jash, Kirloskar, Vaas
20	MCC	Interlec, Positronocs, Jay Switchgear, Chavare Engineering, L&T, Siemens, ABB, Schneider, Crompton, Spark Electro
21	Variable Frequency Drive (VFDs)	ABB, Nord, Mitsubishi
22	PLC	Allen Bradley, Mitsubishi, GE, Siemens, ABB, Honeywell, Schneider
23	SCADA	Allen Bradley, Ellipse, Wonderware
24	Pressure Gauges	H.Guru, Gluck

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25	Level Switches, Level Transmitters	Endress & Hauser, Forbes Marshall
26	PH / ORP Meters, Flow Meters, DO Meters etc.	Endress & Hauser, Forbes Marshall
27	TOC, Turbidity, MLSS & other Analysers	Hach, ABB, Forbes Marshall

TECHNICAL SCHEDULES

The schedule formats given on following pages for technical details of the bidders are to be necessarily filled in by the bidders. Bidder must fill these schedules.

However, the bidder, should feel that the formats or items are not sufficient to cover all types of plant, machinery, automation system etc. that are to be provided by him he is free to provide additional formats for the other items. Those formats however must provide all technical details of items supplied, to enable the employer to scrutinize the adequacy or functionality of these items in the plan. However, no financial data or cost is to be indicated in the Technical Proposal as the same are to be indicated in a separate commercial bid.

SCHEDULE - I

DEVIATIONS FROM TECHNICAL SPECIFICATIONS

NIL

We undertake that our bid is strictly as per the technical specifications, where given in the bid document.

SCHEDULE - II
DEVIATIONS FROM CONDITIONS OF CONTRACT

NIL

We undertake that our bid is strictly as per the conditions and requirements of the bid documents.

Contractor

No. of correction

Executive Engineer

SCHEDULE - III

DESCRIPTION OF WORK

The bidder shall submit a detailed Description of Work i.e. Technical Write-up, Process & Instrumentation Diagram, Layout, Hydraulic Flow Diagram, Electrical Load List, Power Consumption & Chemical Consumption etc.

SCHEDULE -IV
SEWAGE TREATMENT PLANT - OPERATING DETAILS

SL NO	ITEM	UNIT	VALUE
I.	Electrical Loads for Raw Sewage Pumping Station		
1	Total connected load	KVA	
2	Maximum running load	KW	
3	Average running load	KW	
4	Average power factor		
5	Daily average power requirement	KWH/day	
6	Annual average power requirement	KWH/year	
II.	Electrical Loads STP		
1	Total connected load	KVA	
2	Maximum running load	KW	
3	Average running load	KW	
4	Average power factor		
5	Daily average power requirement	KWH/day	
6	Annual average power requirement	KWH/year	

SL NO	ITEM	UNIT	VALUE
V.	Chemical Usage		
1	Average dose for Chlorine	mg/l	
	Maximum dose for Chlorine	mg/l	

Contractor

No. of correction

Executive Engineer

2	Average dose for Dewatering Polyelectrolyte	mg/l	
	Maximum dose for Dewatering Polyelectrolyte	mg/l	

SCHEDULE - V
FUNCTIONAL GUARANTEES

1. General

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

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

2. Functional Guarantees

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

2.1 Quality of Treated Effluent

The quality of treated effluent shall be as follows:

As specified in "**Volume - I - Scope of Work**".

2.2 Electrical Energy Usage

Power requirement of Raw Sewage Pumping Station	Not more than Units per month.
Power requirement of STP	Not more than Units per month.

SCHEDULE -VI
FORMAT FOR ELECTRICAL LOAD LIST & POWER CONSUMPTION

Sr. No.	Description of Equipment	Motor Rating KW	W	S	T	BKW	Operating Hrs. Hrs./day	Power Consumption (Kw.Hrs./day)
1	Mechanical Coarse Screen							
2	Raw Sewage Transfer Pumps							
3	Mechanical Fine Screen							
4	Detritus							
	a. Scraper Mechanism							
	b. Classifier Mechanism							
	c. Organic Return Pumps							
5	Decanters							
6	SBR Air Blowers							
7	RAS Pumps							
8	SAS Pumps							
9	Chlorination Tank							
	a. Water Booster							

Contractor

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Executive Engineer

	Pumps							
	b. NaOH Recirculation Pump							
	c. Air Blower							
10	Sludge Sump Mixers							
11	Centrifuge Feed Pumps							
12	Centrifuge							
13	Agitators for DWPE Dosing Tanks							
14	Dewatering Polymer Dosing Pumps							
15	Service Water Pumps							
16	Auto Valves/Sluice Gates							
17	Plant Area Lighting							
	TOTAL							
	ADD LINE LOSSES & 5% OF ABOVE							
	GRAND TOTAL							

Contractor

No. of correction

Executive Engineer

LATUR CITY MUNICIPAL CORPORATION, LATUR
LATUR CITY UNDERGROUND SEWERAGE SCHEME, LATUR, TAL. &
DIST. LATUR

QUALITY OF INCOMING SEWAGE

Quality of waste-water coming in STP (to be provided by the department but contractor must verify its quality on its own without any challenge to the department and any liability to the Department)

Contractor

No. of correction

Executive Engineer

LATUR CITY MUNICIPAL CORPORATION, LATUR

LATUR CITY UNDERGROUND SEWERAGE SCHEME, LATUR, TAL. &
DIST. LATUR

QUALITY OF OUTGOING SEWAGE

Quality of waste-water coming out of STP (to be provided by the department)

Contractor

No. of correction

Executive Engineer

Payment Break up for 53 MLD Sewage treatment Plant

1. Submission of Flow diagram, P&I Diagram, Layout of units, Hydraulic Calculation with GA drawing and Detailed RCC design with drawings etc. & its approval 2 %
2. Civil Engineering Works 58%
3. Mechanical & Electrical Works 30%
4. Payment withheld and to be released after successful trial runs for 6 Months. 10%

A) Civil Works (58 %)

S.N.	Components	% of Breakup
1.	Inlet Chamber / Stilling Chamber	3%
2.	Screen Chamber	3%
3.	Grit Removal Unit	5%
4.	Biological Rector Unit along with Blower Room	35%
5.	Chemical House and Chemical Dosing Tanks and piping etc.	10%
6.	Mixing tank & Secondary settling Tank	25%
7.	Sludge Disposal System - Sludge Sump, Centrifuge unit etc.	15%
8.	By Pass Arrangement	2%
9.	Plant Drainage System	1%
10.	Internal Road & Misc. Works	1%
	Total	100%

Note: 10 % payment will be withheld through each R.A. Bill for Hydraulic Testing.

B) Mechanical & Electrical Works (30%)

S.N.	Components	% of Breakup
1.	Design & Drawings Approval	2%
2.	Inlet Works	5%
3.	Fine Screen	15%
4.	Grit Removal Mechanism	10%
5.	All arrangement at biological rector along with blower etc.	35%
6.	Sludge Disposal System	15%
6.	By Pass arrangement	10%
7.	Electrification Works in Plant	5%
8.	All Misc. Works	3%
	Total	100%

Note: - 1) This is tentative break up of payment and is to be approved by competent authority by contractor.

2) The above break up of payment can be altered as per the design components accepted by the OMC, if found necessary, of the successful bidder.

Tests on Completion:

The Contractor shall carry out the tests on completion before taking over as per the guide lines of **CPHEEO** Manual of the inspection and testing requirement.

The Schedule of Operating and Maintenance Manuals:

The Contractor has to submit an operation manual after the physical completion of the work. This manual will be submitted as draft at the data of physical completion and as final version 1 (one) month after commissioning, including all the experiences made during the tests and the training given to the operators during the commissioning period.

The maintenance manual shall also include the following:

Procedure for maintenance.

Preventive maintenance procedures for all the equipment.

Emergency maintenance management of the plant and equipment.

SUB WORK NO. 10: - Approach Road

Item No.1: - Clearing and grubbing road land including uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth up to 300 mm, removal of stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable material to be used or auctioned up to a lead of 1000 metres including removal and disposal of top organic soil not exceeding 150 mm in thickness.

Specifications as per item PWD MORTH 201.

Mode of Measurement: Measured and Paid on Square Metre. Basis.

Item No.2: - Excavation for roadway in earth, soil of all sorts, sand, gravel or soft murum including dressing section to the required grade, camber and side slopes and conveying the excavated materials with all lifts up to a lead of 50m. and spreading for embankment or stacking as directed. By Manual Means.

Specifications as per item PWD MORTH 301.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.3: - Providing earth work in embankment with approved materials obtained from other sources up to lead of 50m. including all lifts, laying in layers of 20cm. to 30cm. thickness breaking clods, dressing to the required lines, curves, grades & section, watering and compaction with vibratory roller with V-Sat attachment to achieve not less than 97 % of standard proctor density etc. complete (Material obtained from Other sources)

Specifications as per item PWD MORTH MORTH 305.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.4: - Watering and compacting of embankment formed of materials obtained from the road cutting within a lead of 50 m, not less than 97% of standard Proctor density after laying them in layers of 20 cm. to 30 cm. with vibratory roller.

Specifications as per item PWD MORTH MORTH 305.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.5: - Providing dry trap / granite / quartzite / gneiss, rubble stone soling in 15cm to 20 cm thick layers (including hand packing and compacting), etc. complete.

This item shall be executed as per the description given in the schedule B of relevant item and as directed by Engineer - in-charge.

Mode of Payment: - The item shall be measured and paid for one cubic meter basis

Item No.6: - Construction of granular sub-base by providing close graded material, spreading in uniform layers with motor grader / Paver on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density, complete as per clause 401 -- By Mix in Place Method and Grading - I Material

Specifications as per item PWD MORTH 401.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.7: - Construction of granular sub-base by providing close graded material, spreading in uniform layers with motor grader/ Paver on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density, complete as per clause 401 -- By Mix in Place Method and Grading -II Material

Specifications as per item PWD MORTH 401.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.8: - Prime coat - Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base including cleaning of road surface and spraying, primer at the rate of 0.60 kg/sqm using mechanical means.

Specifications as per item PWD MORTH 502.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.9: - DENSE BITUMINOUS MACADAM: Proving and laying dense bituminous macadam using crushed aggregates of Grading 1, premixed with bituminous binder of specified grade of Bitumen @4.50 per cent by weight of total mix and filler, transported to site with VTS , laid over a previously prepared surface, finished to the required grade, level, alignment, and rolling to achieve the desired density for 76-100 mm compacted thickness .USING Batch mix type hot mix plant with SCADA, Sensor Paver, Vibratory roller with Stone Dust filler.(VG-30 bulk bitumen rates are considered to arrive at rates)

Specifications as per item PWD MORTH 505.

Mode of Measurement: Measured and Paid on Cubic Metre. Basis.

Item No.10: - Providing and applying tack coat on the prepared surface heating by fumes in Boiler and spraying bitumen set footed in bitumen boller on B.T. surface 2.5 kg/10 sqm. (VG-30 bulk bitumen rates are considered to arrive at rates)

Specifications as per item PWD MORTH 503.

Mode of Measurement: Measured and Paid on Square Metre. Basis.

SUB WORK NO. 11: - Staff Quarter at STP

Item No.1: - Excavation for Foundation / pipe trenches in earth, soils of all types, sand gravel and soft mrrum, including removing the excavated material up to a distance of 50 metres and lifts as below m stacking and spreading as directed, manual dewatering, preparing the bed for foundation and excluding backfilling etc. complete. (Bd-A-1 /259)

Item No.2: - Excavation for foundation / pipe trenches in soft rock and old cement and lime masonry foundation asphalt road including removing the excavated material up to a distance of 50 M beyond the area and lifts as below, stacking as directed by Engineer-in-charge, normal dewatering, preparing the bed for foundation and excluding backfilling, etc. complete. (Bd-A-4/259)

Specifications same as per Item No. 1 & 2, Sub work No.2.

Item No.3: - Providing and laying in situ Cement Concrete M-15 of trap/ granite / quartzite / gneiss metal for foundation and bedding including bailing out water, form work, compaction, curing, etc. complete.

(Cement 5.90 bags / cum)

Spec. No. - Bd E /1 Page No. 287 and B-7, Page No. 38

Specifications same as per Item No.21, Sub work No.2.

Item No.4: - Providing and laying in situ Cement Concrete of trap/ granite / quartzite / gneiss metal for RCC work in foundation like raft, grillage, strip foundation and footing of RCC columns and steel stanchions including normal dewatering, form work, compaction, finishing and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement M – 200.

Specifications same as per Item No.1 to 3, Sub work No.4.

Item No.5: - Filling in plinth and floors / trenches with contractor's murum for bedding in 15 cm to 20 cm layers including watering and compaction, etc. complete. (Bd-A-11/263)

Specifications same as per Item No.5, Sub work No.2.

Item No.6: - Providing and casting in situ Cement Concrete of trap/ granite / quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer- in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with CM 1:3 of sufficient minimum thickness if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and

M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) In RCC M-200 -All types of Column.

Item No.7: - Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) In RCC M-200 - -For Beams / Braces / Lintels

Item No.8: - Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) In RCC M-200 - Chajjas / Parapets / Curtain Walls / Partition Walls / Pardies.

Item No.9: - Providing and casting in situ C.C. of trap / granite/ quartzite / gneiss metal of approved quality for RCC works as per detailed drawings and designs or as directed by Engineer-in-charge including normal dewatering, centering, form work, compaction, finishing the formed surfaces with C.M. 1:3 of sufficient minimum thickness to give a smooth and even surface wherever necessary or roughening if special finish is to be provided and curing, etc. complete. (By weigh batching and mix design for M-250 and M-300 only. Use of L&T, A.C.C., Ambuja, Birla Gold, Manikgad, Rajashree, etc. cement is permitted.) (Excluding M.S. or Tor reinforcement) In RCC M-200 - Slabs / Landings / Vertical Walls / Waist.

Specifications same as per Item No.1 to 3, Sub work No.4.

Item No.10: - Providing and fixing in position steel bar reinforcement of various diameters for RCC piles, caps, footings, foundations, slabs, beams, columns, canopies, staircases, newels, chajjas, lintels, pardies, copings, fins, arches, etc. as per detailed designs, drawings and schedules; including cutting, bending, hooking the bars, binding with wires or tack welding and supporting as required, etc. complete (including cost of binding wire). (Bd-F-17/306)

Specifications same as per Item No.4, Sub work No.4.

Item No.11: - Providing second class Burnt Brick masonry with conventional/ I.S. type bricks in cement mortar 1:6 in superstructure including striking joints, raking out joints, watering and scaffolding etc. Complete.

Specifications same as per Item No.5, Sub work No.4.

Item No.12: - Providing internal cement plaster 12mm thick in single coat in cement mortar 1:3 without neeru finish to concrete or brick surfaces, in all position including scaffolding and curing etc. complete.

Specifications same as per Item No.6, Sub work No.4.

Item No.13: - Providing sand faced plaster externally in cement mortar using approved screened sand, in all positions including base coat of 15 mm thick in cement mortar 1:4 using waterproofing compound at 1 kg per cement bag curing the same for not less than 2 days and keeping the surface of the base coat rough to receive the sand faced treatment 6 to 8 mm thick in cement mortar 1:4 finishing the surface by taking out grains and curing for fourteen days scaffolding etc. complete.

Specifications same as per Item No.7, Sub work No.4.

Item No.14: - Providing neeru finish to plastered surfaces in all positions including scaffolding and curing etc. complete.

Specifications same as per Item No.8, Sub work No.4.

Item No.15: - Providing and fixing in position. (as per I.S.1868 / 1982) Aluminium sliding window of two tracks with rectangular pipe having overall dimension 63.50 x 38.10 x 1.02 mm at weight 0.547 kg/Rmt. and window frame bottom track section 61.85 x 31.75 x 1.20 mm at weight 0.695 kg/Rmt. Top and side track section 61.85 x 31.75 x 1.30 mm at weight 0.659 g/Rmt. The shutter should be of bearing bottom 40 x 18 x 1.25 mm at weight 0.417 kg/Rmt. Inter locking section 40 x 18 x 1.10 mm at weight 0.469 kg/Rmt. And handle section 40 x 18 x 1.25 mm at weight 0.417 kg/Rmt. and top section 40 x 18 x 1.25 mm at weight 0.417 kg/Rmt. As per detailed drawings and as directed by Engineer in charge with all necessary Aluminium sections fixtures and fastenings such as roller bearing in nylon casting and self-locking catch fitted in vertical section of shutter including 5 mm thick plain glass with all required screws and nuts etc, complete. With colour Anodizing with box.

Specifications same as per Item No.9, Sub work No.4.

Item No.16: - Providing and fixing mild steel grill work for windows, ventilators etc. 20 kg/sqm as per drawing including fixtures, necessary welding and painting with one coats of anticorrosive paint and two coats of oil painting complete.

Specifications same as per Item No.11, Sub work No.4.

Item No.17: - Providing and fixing steel ventilator fully glazed partly fixed as per detailed drawing without hot dip zinc coating including fabricating glazing with plain / obscured glass panes 5 mm thick and approved type and quality and iron oxidized fixtures and fastening oil paint 2 coats etc. complete.

Specifications same as per Item No.12, Sub work No.4.

Item No.18: - Providing and applying three coats of water proof cement paint of approved manufacture and of approved colour to new plastered surfaces including scaffolding if necessary, cleaning and preparing the surface, watering for two days etc. complete.

Specifications same as per Item No.13, Sub work No.4.

Item No.19: - Providing and applying washable oil-bound distemper of approved colour and shade to old and new surfaces in two coats including scaffolding, preparing the surfaces. (excluding the primer coat.) etc. complete.

Specifications same as per Item No.14, Sub work No.4.

Item No.20: - Providing and laying machine cut machine Polished Kota stone flooring 25mm to 30mm thick and required width in plain/ diamond pattern on bed of 1:6 C. M. including cement float, filling joints with neat cement slurry, curing, polishing and cleaning etc. complete.

Specifications same as per Item No.15, Sub work No.4.

Item No.21: - Refilling the trenches with available excavated stuff with soft material first over pipeline and then hard material in 15 cm layers with all leads and lifts including consolidation, surcharging, etc. complete.

Specifications same as per Item No.18, Sub work No.4.

SUB WORK NO. 12: - Compound Wall for STP

Item No.1: - Excavation for foundation / pipe trenches in hard murum including removing the excavated material up to a distance of 50 M and lifts as below, stacking and spreading as directed by Engineer-in-charge, normal dewatering, preparing the bed for foundation and excluding backfilling, etc. complete.

Specifications same as per Item No.1 & 2, Sub work No.2.

Item No.2: - Providing and laying in situ cement concrete M-15 of trap metal for foundation and bedding including bailing out water, formwork, compaction and curing complete. For M-150 Concrete.

Specifications same as per Item No.21, Sub work No.2.

Item No.3: - Providing & laying in situ Ready mix cement concrete grade of trap / granite/ quartzite / gneiss metal for RCC works in foundation and footing of RCC column and steel stanchions including normal dewatering, form work, compaction finishing and curing including transporting from mixing plant upto distance of 25Km, pouring the concrete at work site for 1.5m lift above G.L. and 5.0m lift below GL etc. complete. (Excluding reinforcement) M-200 Footings.

Item No.4: - Providing & laying in situ Ready mix cement concrete grade of trap / granite/ quartzite / gneiss metal for RCC works in foundation and footing of RCC column and steel stanchions including normal dewatering, form work, compaction finishing and curing including transporting from mixing plant up to distance of 25Km, pouring the concrete at work site for 1.5m lift above G.L. and 5.0m lift below GL etc. complete. (Excluding reinforcement) M-200 Column.

Item No.5: - Providing & laying in situ Ready mix cement concrete grade of trap / granite/ quartzite / gneiss metal for RCC works in foundation and footing of RCC column and steel stanchions including normal dewatering, form work, compaction finishing and curing including transporting from mixing plant up to distance of 25Km, pouring the concrete at work site for 1.5m lift above G.L. and 5.0m lift below GL etc. complete. (Excluding reinforcement) Beams & Lintels M-200.

Specifications same as per Item No.1 to 3, Sub work No.4.

Item No.6: - Providing & fixing in position steel bar reinforcement of various diameters for R.C.C. piles caps footings foundations slabs beams, lintels, slabs beams columns canopies staircase newels, chajjas, lintels pardiies copings fins, arches, etc. as per detailed designs, drawings and schedules including cutting, bending, hooking the bars, binding with wires or tack welding and supporting as required complete. (including cost of binding wires)

Specifications same as per Item No.4, Sub work No.4.

Item No.7: - Refilling the trenches with available excavated stuff with soft material, first over pipeline and then hard material in 15cm layers with all leads and lifts, including consolidation, surcharging etc. complete.

Specifications same as per Item No.18, Sub work No.2.

Item No.8: - Providing second class Burnt Brick masonry with conventional/ I.S. type bricks in cement mortar 1:6 in plinth as backing in composite masonry including bailing out water manually, striking joints, raking out joints and watering etc. Complete.

Specifications same as per Item No.5, Sub work No.4.

Item No.9: - Providing sand faced cement plaster externally in two coats to brick or stone masonry surfaces in all positions with base coat of 12 to 15mm thick in c.m.1:4 and rough cast treatment 12mm thick in proportion 1:11/ 2:3 including scaffolding and fourteen days curing complete.

Specifications same as per Item No.7, Sub work No.4.

Item No.10: - Providing and fixing MS Gate 2.5 M Wide for compound with 40 mm dia. GI pipe medium class, approved grill work, RCC M-15 side pillars of 25cm x 40cm x 2.5 M height, its foundation, finishing, painting etc. complete.

The relevant item shall comply as per Schedule 'B' and as directed by Engineer in Charge.

Mode of Measurement & payment

The item shall be measured and paid on No. basis.

Item No.10: - Providing and fixing Wicket Gate 1.0 M Wide for compound with 40 mm dia. GI pipe medium class, approved grill work, RCC M-15 side pillars of 25cm x 40cm x 2.5 M height, its foundation, finishing, painting etc. complete.

The relevant item shall comply as per Schedule 'B' and as directed by Engineer in Charge.

Mode of Measurement & payment

The item shall be measured and paid on No. basis.

SUB WORK NO. 13: - Fencing Work

Item No.1: - Providing and erecting chain link fencing 1.6 M. height with G.I. chain link of size 50 x 50 mm, 8 gauge thick and fixed 75 mm above ground level on vertical M.S. Angles of 40 x 40 x 6 mm size, including excavating pits for foundation and embedded in C.C. block of 1:4:8 mix of size 450 x 450 x 670 mm. at 1.75 M. c/c with iron bar 16mm dia as hold fast including welding link with angle frame at 30 cm c/c with nuts and bolts and horizontal M.S. Angles at top and bottom of 25 x 25 x 5 mm size and vertical M.S. flat 35 x 5 mm and 25 x 5 mm horizontal including cross support of 40 x 40 x 6 mm angles both side at every corner or bend embedded in concrete blocks of 1:4:8 of size 450 x 450 x 670 mm including 3 coats of oil painting etc. complete.

MODE OF MEASUREMENT

This item will be measured and paid as per Rm. basis.

Item No.2: - Providing and fixing M.S. gate 2.5 M wide for compound with 40 mm dia G.I. pipe, approved grill work, RCC M-150 side pillars of 25 cm x 40 cm x 2.5 M height, its foundation, finishing, painting, etc. complete.

MODE OF MEASUREMENT

This item will be measured and paid as per No. basis.

Item No.3: - Providing and fixing Wicket gate 1.0 M wide for compound with 40 mm dia G.I. pipe, approved grill work, RCC M-150 side pillars of 25 cm x 40 cm x 2.5 M height, its foundation, finishing, painting, etc. complete

MODE OF MEASUREMENT

This item will be measured and paid as per No. basis.

SUB WORK NO. 14: - Flood Protection wall

Item No.1: - Excavation for Foundation for works of Flood Protection wall/ Retaining Wall in all types of Soil , earthy or sandy materials, soil of all type of sand, clay mud, Soft Murum ,soft average or hard murum, Boulders, all type of disintegrated rock ,shingles, brick bats ,isolated boulders of any size, all type of rock including soft ,hard and manjara rock by permissible and suitable methods such as Controlled blasting, chiseling, wedging, line drilling and or by use of mechanical means including excavation in all type of road surfaces such as WBM, Asphalt, concrete road, including trimming the surface by chiselling whenever required including removing the roots of trees met with during excavation levelling the bed and keeping it clean and dry by dewatering and making ready for PCC, manual dewatering, excluding backfilling including removing the excavated stuff up to a distance of 50 m beyond the work site and stacking the same as directed by Engineer in charge etc. complete for lift as mentioned below. Lift 0 -1.50 M

Specifications same as per Item No.1, Sub work No.2a.

Item No.2: - Providing and laying Cast in situ/Ready Mix cement concrete in M15 of trap/ granite/quartzite/gneiss metal for foundation and bedding / steps including steel centering, formwork, laying/pumping, compacting, roughening them if special finish is to be provided, finishing uneven and honeycombed surface and curing etc. complete. The Cement Mortar 1:3 plaster is considered for rendering uneven and honeycombed surface, only. Newly laid concrete shall be covered by gunny bag, plastic, tarpaulin etc. (Wooden centering will not be allowed.), with fully automatic microprocessor-based PLC with SCADA enabled reversible Drum Type mixer/concrete Batch mix plant (Pan mixer) etc. complete. With fine aggregate (Crushed sand VSI Grade)

Specifications same as per Item No.21, Sub work No.2a.

Item No.3: - Providing and laying Cast in situ/Ready Mix cement concrete M-25 of trap / granite/quartzite/ gneiss metal for R.C.C. work in foundations like raft, strip foundations, grillage and footings of R.C.C. columns and steel stanchions etc. including bailing out water, Steel centering, formwork ,cover blocks, laying/pumping, compaction and curing roughening the surface if special finish is to be provided (Excluding reinforcement and structural steel) etc. complete, with fully automatic microprocessor based PLC with SCADA enabled reversible Drum Type mixer/ concrete Batch mix plant (Pan mixer) etc. complete. With fine aggregate (Crushed sand VSI Grade)

Specifications same as per Item No.1 to 3, Sub work No.4.

Item No.4: - Providing and laying Cast in situ/Ready Mix cement concrete in M-25 of trap/ granite/ quartzite/ gneiss metal for R.C.C. pardi of required thickness including steel centering, formwork, cover blocks, laying/pumping, compacting and roughening them if special finish is to be provided and curing complete. (Excluding reinforcement and structural steel). with fully automatic microprocessor-based PLC with SCADA enabled reversible Drum Type mixer/ concrete Batch mix plant (Pan mixer) etc. complete. With fine aggregate (Crushed sand VSI Grade)

Specifications same as per Item No.1 to 3, Sub work No.4.

Item No.5: - Providing and fixing in position TMT - FE - 500 bar reinforcement of various diameters for R.C.C. pile caps, footings, foundations, slabs, beams columns, canopies, staircase, newels, chajjas, lintels pardis, copings, fins, arches etc. as per detailed designs, drawings and schedules. including cutting, bending, hooking the bars, binding with wires or tack welding and supporting as required complete.

Specifications same as per Item No.4, Sub work No.4.

Item No.6: - Providing and fixing bituminous pad 25mm thick for expansion joints in retaining wall, compound wall etc. complete.

MODE OF MEASUREMENT

This item will be measured and paid as per Sq m basis.

Item No.7: - Providing and laying weep holes of 100 mm diameter PVC pipes as per drawing for abutment returns, return walls etc. Complete.

This item will be measured and paid as per RMT basis.

Item No.8: - Providing and erecting chain link fencing 1.6 M. height with G.I. chain link of size 50 x 50 mm, 8 gauge thick and fixed 75 mm above ground level on vertical M.S. Angles of 40 x 40 x 6 mm size, including excavating pits for foundation and embedded in C.C. block of 1:4:8 mix of size 450 x 450 x 670 mm. at 1.75 M. c/c with iron bar 16mm dia as hold fast including welding link with angle frame at 30 cm c/c with nuts and bolts and horizontal M.S. Angles at top and bottom of 25 x 25 x 5 mm size and vertical M.S. flat 35 x 5 mm and 25 x 5 mm horizontal including cross support of 40 x 40 x 6 mm angles both side at every corner or bend embedded in concrete blocks of 1:4:8 of size 450 x 450 x 670 mm including 3 coats of oil painting etc. complete.

Specifications same as per Item No.1, Sub work No.13.

Item No.9: - Refilling the trenches with available excavated stuff with soft material first over pipeline and then hard material in 15 cm layers with all leads and lifts including consolidation, surcharging, etc. complete.

Specifications same as per Item No.18, Sub work No.2.

Item No.10: - Filling in plinth and floors with approved excavated material in 15cm. to 20cm. Layers including watering and compacting etc. complete.

Specifications same as per Item No.6, Sub work No.2a.

Item No.11: - Removing and transporting the excavated surplus material of all categories and disposing of the same as directed, including loading, conveying, spreading or stacking beyond the initial lead of 5 Km as directed etc. complete.

Specifications same as per Item No.19, Sub work No.2a.

SUB WORK NO. 15: - Trial & Run for 3 Months

Item No.1: - Commissioning, running and maintaining the scheme the to quantities, rated capacity, including managing necessary personnels such as operator, valve man, labour etc. as per requirements of the scheme and who should also administrator, chemical dose for period of six months together with training of personnels spared by local body and handing over scheme to local body after completion of the above period as directed by engineer in charge.

TRIAL & RUN FOR 3 months

Work should be carried out as directed by Engineer-in-charge.

Mode of Measurement & Payment: Measurement and payment will be paid on Job basis.