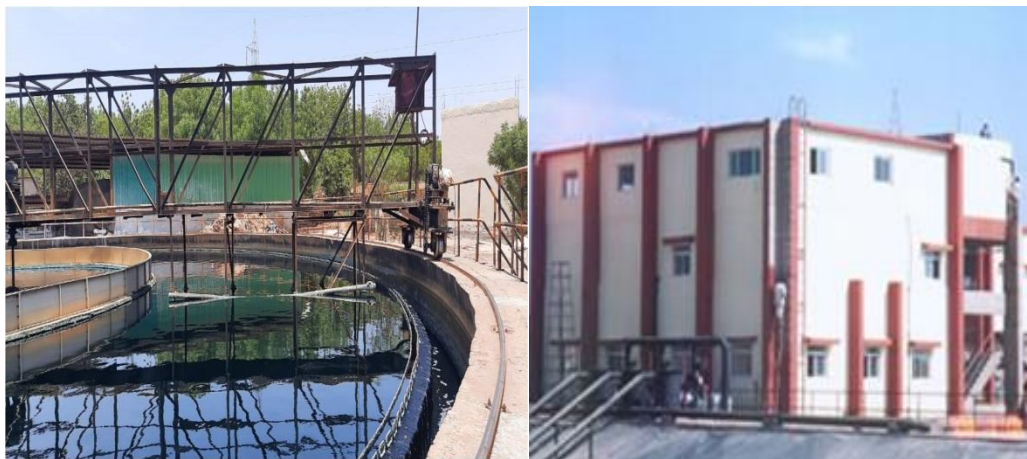


**TENDER DOCUMENTS FOR
UP-GRADATION OF 10 MLD OUT OF
EXISTING 18.5 MLD CETP (ALKALINE
STREAM)**

**JODHPUR POLLUTION CONTROL & RESEARCH
FOUNDATION, JODHPUR**



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Part -A: Technical Proposal and existing details

1 INTRODUCTION

1.1 Project Background

SUN city of Jodhpur situated in Rajasthan, poised for rapid industrialization. Industries such as textile, S.S. rolling mills, Guar gum, Chemicals, Cements are developed and under development.

Most of these industries are located in the industrial complex under Rajasthan Industrial Development and Investment Corporation Ltd. (RIICO).

In order to treat effluents from these industries Jodhpur Pollution Control and Research Foundation, (JPCRf) is operating 18.5 MLD capacity (Alkaline Effluent) CETP before they are disposed.

Jodhpur Pollution Control and Research Foundation, Jodhpur (JPCRf) having its registered office at plot no sp-1 Sangariya Industrial Area phase II Sangariya, Jodhpur (Rajasthan). JPCRf has been constituted to cater the needs of Textiles Hand Processing units of the following Industrial areas of Jodhpur city.

1. Industrial Estate
2. Light Industrial Area
3. Heavy Industrial Area
4. Industrial Area near New Powerhouse
5. New Jodhpur Industrial Area
6. Marudhar Industrial Area Basni Phase I
7. Marudhar Industrial Area Basni Phase II

Apart from these above industrial areas some units adjoining to Marudhar Industrial Area Basni phase II are also the beneficiary members of the trust. At present in all there are about 303 Textile beneficiary members. These members have industrial units related to textiles. JPNT has installed a Common Effluent Treatment Plant (CETP) of capacity of 20 MLD in the

year 2003-04 for treating textile & steel effluent. JPCRF was constituted in 2017 and is in operation & maintenance of textile CETP from 2021. The entire alkaline effluent is transmitted in RCC NP -4 conduit pipe networks.

The total installed capacity of the plant is 20 MLD (18.5+1.5) out of which 18.5 MLD (Approx) is allotted to the alkaline effluent received from the textile units and 1.5 MLD (Approx) for acidic effluent. The JPCRF is responsible for treating textile effluents as per the Rajasthan State Pollution Control Board (RSPCB) guidelines.

2 LAND AND LOCATION OF PROJECT

2.1 Location of Project

Sangaria Town is the one of the fully developed area of Rajasthan. Sangaria, situated at Latitude 26.196699 and Longitude – 73.008506.

The climate of the district is semi-dry, extremely hot during the summer and extremely cold during winter. The maximum average temperature varies between 18 and 48 °C and the minimum averages between 0 and 28 °C. The average rainfall during the year is 225 to 300 mm.



Map of Sangariya, Jodhpur

3 EXISTING TREATMENT PLANT

The alkaline stream was designed for the 18.5 MLD but at present influent characteristics are different as compared to earlier so right now plant is operated at 10-12 MLD. To achieve the desired quality, JPCRf intends to upgrade the 10 MLD out of existing 18.5 MLD plant at all variations of input condition.

3.1 Existing Treatment scheme

Alkaline Stream CETP receives the textile effluent discharged from the textile industrial units. The entire alkaline effluent is transmitting in RCC NP -4 conduit pipe networks.

In order to treat effluents from textile industries, JPCRf is operating 18.5 MLD CETP. The existing treatment scheme is based on Physico – Chemical treatment followed by biological treatment and PSF & ACF filtration process to achieve the desired quality of final effluent.

To handle the fluctuation in quality of incoming effluent and higher inlet parameter, the treatment scheme shall be upgraded by introduction of additional physico-chemical unit (DAF) and increase in the aeration capacity to achieve the desired output norm. Also polishing DAF is introduced, so that feed TSS to filtration system is got reduced and increased efficiency of filtration can be achieved.

3.2 Process Description of existing CETP

Process as well as brief detail of existing CETP units is explained in following pages.

3.2.1 Inlet Chamber

Effluent from the RCC NP -4 conduit pipe is taken to the inlet chamber. For flow measurement flow meter is installed at inlet chamber.



Inlet Chamber

1	Inlet Chamber	
	Design flow	18.5 MLD
	Present flow	12 MLD
	Quantity	1 No.
	Size	2.0 m x 1.5 m x 1.74 m LD
	MOC	RCC

3.2.2 Screen Chamber

From inlet chamber effluent enters in to one mechanical bar screen for removal of floating and oversized material.



Screen chamber

2	Screen Chamber	
	Quantity	1 No.
	Size	2.0 m x 1.1 m x 1.3 m LD
	MOC	RCC

3.2.3 Grit Chamber

From screen chamber effluent enters into the grit chamber. Grit chamber is designed to slow down the flow so that solids such as sand, silt particles and fine particles are settled out of the water. Degritting is the important part of the process, as presence of grit causes excessive wear and tear on pumps and other plant equipment.



Grit Chamber

3	Grit Chamber	
	Quantity	1 No.
	Size	11.5 m x 6.4 m x 1.5 m LD
	MOC	RCC

3.2.4 Equalization Tank

- Degritted effluent from the grit chamber is transferred into the equalization tank. This equalization system is provided to Improve biological treatment and stabilize pH of wastewater along with making consistency in solids loading.
 - Equalize the BOD and TSS loading to improve chemical feed control and process reliability.



Equalization Tank

4	Equalization tank	
	Quantity	1 No
	Size	77.12 m x 37.12 m (top) 64.0 m x 24.0 m (bottom) x 2.0 m LD
	volume	4330 m ³
	Air Blower	
	Nos. of air blower	4 (2W + 2S)
	Capacity	3250 m ³ /hr. x 4000 MMWC
	Drive Motor	75 HP, 1540 RPM
	Equalization Transfer pump house	
	Quantity	2 Nos. (2W + 1S)
	Pump Capacity	315 m ³ /hr.
	Pump Head	12 m
	pump motor	30 HP
	Number of diffusers	550 nos. snap cap diffuser.

3.2.5 Mixing Channel

Effluent is pumped from the equalisation tank to mixing channel. Coagulants and other chemicals are blended with wastewater in Mixing Channel. Wastewater mixed with chemicals is passing through flash mixer prior to flocculation.



Mixing Channel

5	Mixing Channel	
	Quantity	1 No.
	Size	8.5 m x 5.2 m x 0.9 m LD + 0.3 m FB
	HRT	4 min
	Flash Mixer	
	Quantity	1 No.
	Size	2.9 m x 2.9 m x 2.5 m LD + 0.5 m FB
	HRT	2 min

3.2.6 Primary Clarifier

The effluent with neutralized pH is then entered into the Primary Clarifier. Influent wastewater enters the clarifier through a central energy-dissipating well designed to minimize turbulence and distribute flow uniformly. The drastic reduction in horizontal velocity allows suspended solids with a specific gravity greater than water to settle to the tank floor, forming primary sludge. A mechanical scraper mechanism continuously moves the settled sludge into a central collection hopper for periodic withdrawal and pumping to the sludge management system. The clarified primary effluent overflows across peripheral V-notch weirs and flows by gravity to the secondary biological treatment stage.



Primary Clarifier

6	Primary Clarifier	
	Quantity	1 No.
	Size of Clarifier	32 m dia. x 2.5 m SWD

3.2.7 Aeration Tank

The clarified effluent is sent to the aeration tank for biological treatment. In aeration tank bacterial culture is maintained in suspension that removes the BOD present in the incoming wastewater. In aeration tank, air is introduced through diffused aeration system along with a network of piping and blowers for oxidation.



Aeration Tank

	Aeration Tank -1	
	Size	Top - 70.0 m x 44.0 m Bottom – 52.0 m x 20.0 m
	Liquid Depth	4.7 m
	Volume of modified tank	9250 m ³
	HRT	15 hrs.
	Air Blower	
	Nos. of air blower	2 (1w + 1s)
	Capacity	3400 m ³ /hr. @ 0.4 kg/cm ²
	Drive Motor	100 HP, 1500 RPM
	Nos. of air blower	2 (1w + 1s)
	Capacity	7500 m ³ /hr. @ 0.5 kg/cm ²
	Drive Motor	180 HP, 1440 RPM
	Aeration Tank – 2 & 3	
	No. of tanks	2 Nos.
	Size of each tank	15 m x 30 m

	LD	4 m
	Volume	1800 m ³

3.2.8 Secondary Clarifier

The secondary clarifier can be described as a circular basin where effluent from the activated sludge process is held. The biomass of microorganisms settles to the bottom in the form of activated sludge. After settling over a period of time, this biomass of microorganisms is returned to the aeration tank with the help of recirculation pumps.



Secondary Settling Tank

8	Secondary Settling Tank	
	Quantity	1 No.
	Size	32 m dia. x 2.5 m SWD
	Motor Rating	1 HP

3.2.9 Clarifier Treated Water Tank

Clear effluent from the Secondary Settling Tank is collected in the clarifier treated water tank.



Clarified Treated Water Tank

14	Clarifier Treated Water Tank	
	Quantity	1 no.
	Size	13.5 m dia. x 3.0 m LD
	HRT	30 min

3.2.10 PSF & ACF

The treated effluent from the clarifier treated water tank is further pumped to 10 nos. of Pressure Sand Filter for filtration of water. Filtered water is further treated in 10 nos. of Activated Carbon Filter to remove traces of color and other contaminant if present. Finally, the treated water is disposed in drain to Jojari River.



PSF AND ACF

15	Pressure Sand Filter (PSF)	
	Quantity	4 nos.
	Size	3.4 m dia. x 2.2 m ht.
	Quantity	5 nos.
	Size	3.0 m dia. x 1.8 m ht.
16	Activated Carbon Filter (ACF)	
	Quantity	4 nos.
	Size	3.4 m dia. x 2.2 m ht.
	Quantity	5 nos.
	Size	3.0 m dia. x 1.8 m ht.

3.2.11 Sludge Treatment Units

3.2.11.1 Primary Sludge Sump

The sludge from the Primary Clariflocculator is collected by gravity in the Primary sludge sump. From Primary sludge sump effluent is pumped through Primary sludge transfer pump to the new sludge thickener to improve the consistency of sludge before dewatering.



Primary Sludge Sump

17	Primary Sludge Sump	
	Quantity	1 No.
	Size	4.0 m x 4.0 m x 5.7 m LD + 0.3 m FB
	Primary Sludge Transfer Pump	
	No. of Pump	1W
	Capacity	60 m ³ /hr.
	Head	8 kg/cm ²
	Type	Diaphragm Type
	No. of Pump	1S
	Capacity	50 m ³ /hr.
	Head	2 kg/cm ²
	Type	Screw Type

3.2.11.2 Secondary Sludge Sump

The excess sludge from the Secondary Settling Tank is collected by gravity in the Secondary Sludge Sump. From Secondary Sludge Sump effluent is pumped through Secondary Sludge Transfer pump to the new sludge thickener to improve the consistency of sludge before dewatering.



Secondary Sludge Sump

18	Secondary Sludge Sump	
	Quantity	1 No.
	Size	2.2 m x 2.2 m x 5.7 m LD + 0.3 m FB

3.2.11.3 Volute press/Decanter

For dewatering of sludge from primary and biological treatment units, volute press is provided.



Volute press

19	Volute press feed pump	
	No. of pump	1W
	Type of pump	Diaphragm type
	Capacity of pump	100 m ³ /hr.
	Pressure	8 kg/cm ²
	Motor Rating	30 HP
	No. of pump	1s
	Type of pump	Screw type
	Capacity of pump	50 m ³ /hr.
	Pressure	2.0 kg/cm ²
	Motor Rating	12.5 kw
20	Volute press	
	Quantity	2 Nos. (1W + 1S)

	Capacity of Volute press	25 m ³ /hr.
	Motor rating	40 HP
	No. of Volute press	1 No.
	Capacity	40 m ³ /hr.

3.2.12 Dosing Tanks and Pumps

21	Lime Preparation Tank	
	Quantity	3 Nos.
	Size	9 m x 4.8 m x 2.5 m + 0.2 m FB
	<i>Lime Solution Tank Agitator</i>	
	Quantity	3 Nos.
	Motor Rating	3 HP
22	Ferrous Solution Preparation Tank	
	Quantity	2 Nos.
	Size	3.6 m x 3.6 m x 2.4 m + 0.2 m FB
	<i>Ferrous Solution Tank Agitator</i>	
	Quantity	2 No.
	Motor Rating	3 HP
23	Polyelectrolyte solution tank	
	Quantity	1 No.
	Size	2.3 m dia. x 2.4 m LD
	Capacity	10 m ³
	<i>Polyelectrolyte Tank Agitator</i>	
	Quantity	1 Nos.
	Motor Rating	3 HP

3.2.13 Existing Buildings

24	Chemical House	
	Quantity	1no.
	Size	15.0 m x 15.0 m
	MOC	RCC frame structure with masonry wall.
25	Volute press Building	
	Quantity	1 no.

	Size	6.7 m x 6.7 m
	MOC	RCC frame structure with masonry wall.
26	Equalization Blower Room	
	Quantity	1 no.
	Size	5.5 m x 5.5 m
	MOC	
27	Aeration Blower Room (Old)	
	Quantity	1 no.
	Size	5.5 m x 5.5 m
	MOC	
28	Aeration Blower Room (New)	
	Quantity	1 no.
	Size	11.0 m x 5.5 m
	MOC	
29	DG Room	
	Quantity	1 no.
	Size	10.5 m x 4.0 m
	MOC	
30	New Panel Room	
	Quantity	1 no.
	Size	8.3 m x 4.0 m
	MOC	
31	CTPT Room	
	Quantity	1 no.
	Size	3.8 m x 3.0 m
	MOC	

32	Guard Room	
	Quantity	1 no.
	Size	10.0 m x 3.5 m
	MOC	
33	Scrape Room	
	Quantity	1 no.
	Size	13.0 m x 4.0 m
	MOC	

4 Extent of Scope of Work

The scope of work under this Single Responsibility Contract includes construction of all works as described in subsequent section to achieve the objective to treat the effluent as per the stipulated standards, to produce water which can be disposed to water body as per good and acceptable engineering practices and workmanship manner.

After successful commissioning and completion of work plant to be handed over to client.

Wherever reference is made of the employers design, drawings, or concept, it may be understood that these are concepts of the employer and the responsibility for correctness of designs, drawings and safety of equipment/structure shall rest on the contractor. Bidders are advised to inspect the site for further clarifications and to understand the scope of work. It is the bidder's responsibility to carry out all the works required to complete the scheme under this project whether it has been mentioned or not.

5 Scope of Work

The scope includes all the work including Upgradation of 10 MLD out of the existing 18.5 MLD CETP including civil, mechanical, electrical and instrumentation works. This tender includes only phase – I.

The brief scope of work for Phase – I (10 MLD) Upgradation of existing Common Effluent Treatment Plant is mentioned as under.

Design, Construction, Supply, Installation, Testing, Commissioning, Trial run of pre-DAF, existing primary clarifier converted to clariflocculator, additional jet aerators for the biological treatment, replacement of existing sand media with glass media filters and replacement of activated carbon media with existing activated carbon media, additional sludge sump & pump & sludge dewatering facility & chemical dosing & building.

Table 1: Proposed quality of CETP

Sr. No.	Parameters	CETP inlet	Required CETP O/L after Filters
1.	pH	9.5 - 11	6.5 – 8.5
2.	Total Dissolve Solids (TDS), mg/l	6000 - 8000	6000 - 8000
3.	Total Suspended Solids (TSS), mg/l	1200 - 1800	<10
4.	Chemical Oxygen Demand (COD), mg/l	1600 - 2500	<100
5.	BOD	400 - 500	<20
6.	O & G	< 50	<2
7.	Total Hardness, mg/l	250 - 350	<150

The effluent from the existing pre-treatment units, i.e. Inlet Chamber, Screen Chamber, Grit Chamber and Equalization tank, shall be work for existing flow and is suitable up to 10 MLD and no modification is required. Primary Clarifier shall be converted to the Clariflocculator for removal of hardness with lime and soda ash dosing. After the primary treatment, effluent shall be transferred to Clariflocculator. After the clariflocculator effluent shall be transferred to the proposed to new DAF feed sump & PH and it shall be pumped to the proposed 2 Nos. of DAF each of 50% capacity. Effluent from the clariflocculator shall be transferred to the proposed DAF. After the DAF effluent shall be transferred to the existing Aeration tank followed by existing Secondary Clarifier. As per the revised inlet quality additional Aerators shall be provided for biological treatment. Effluent from the existing Secondary Clarifier shall be transferred to the existing clarifier storage tank. Existing media of PSF shall be replaced with glass media and existing carbon filter media shall be replaced with new activated carbon media. Effluent from the clarifier storage tank shall be pumped to the Media Filters. Effluent from the Media filter shall be disposed off in to water body.

Sludge from physio- chemical treatment shall be taken to the proposed Primary Sludge sump from there it shall be pumped to the existing as well as proposed volute press while excess sludge from the biological treatment shall be transferred to the Secondary Sludge sump from where it pumped to existing sludge dewatering.

Up gradation of existing process scheme of CETP (Phase – I)

- Primary Clarifier converted to Clariflocculator
- DAF feed Sump & Pump
- Pre- Dissolved Air Flotation (DAF) with accessories and chemical dosing
- Surface jet Aerators for Biological treatment
- Media replacement i.e PSF shall be replaced with Glass media filter including underdrainage system and existing carbon media with new carbon media (only media)
- Chemical Sludge Sump & Pumps
- Mechanical sludge dewatering unit (Volute press).
- Chemical dosing building which includes tanks and storage

5.1.1 The other units required in scope of bidder are:

- a) Rectification / repairing work (plaster and paints) for Existing civil Units (if any required) after necessary stability / NDT testing of existing structure as there are leakages in to existing units.
 - b) Earth filling, leveling and dressing around the treatment unit including cutting of trees, removal of debris, shrubs, etc. within the premises of treatment plant & filling, to bring the site up to formation level, landscape, tree plantation, shall be included in the scope of work of this contract.
1. All inter-connecting pipes, channels, valves, fixtures and appurtenances.
 2. Supply, erection, testing, commissioning of various mechanical, electrical & instrumentation equipment's required for the smooth working of the entire proposed treatment plant.
 3. Plant to be handed over in full working condition (including all standby units to be in full working condition) at the time of handover.
 4. Any other item not indicated above but necessary, essential or incidental to the completion of the above works and making them operational.

5.2 General Principles

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

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

Submission of all documents required according to the Contract (security money/guarantee, insurance policies, if any etc.)

5.3 Preparatory Work

The Contractor shall use the land earmarked to accommodate for sitting of all the units of the final capacity of proposed works.

The Contractor shall construct approach roads connecting to all treatment units, and ancillary civil structures to be constructed within the campus from the main road up to Plant site. The contractor will have to use the same for transporting the materials to the site.

The Contractor shall construct a benchmark at a suitable location within the campus establish a GTS benchmark with an arbitrary coordinate of (0.00, 0.00) at a suitable location within the site and transfer level from the existing benchmark, as approved by the Engineer-in-charge. All levels shall be deemed to refer to that benchmark. The Contractor may establish other secondary benchmarks on the site, where required.

5.3.1 Soil Investigation

The Contractor in co-ordination with the Engineer in Charge has to determine at each location of a building or a water retaining structure the soil characteristics (safe bearing capacity, angle of friction, cohesion) in order to calculate the dimensions of the foundations. It is also important to assess the potential of changes in water table, erosion and exposure of foundations and the stability of the soil with view to the lateral resistance to be taken into account.

The soil conditions have to be analyzed for all important structures of the effluent treatment plant. The required soil analysis are:

a) Penetration tests

- Standard penetration test to a depth corresponding to at least 1.5 times the width of the building/foundation.

b) Plate load tests:

- To assess soil bearing capacity at the foundation level (Plate test)
- To take samples for laboratory analyses

c) Laboratory analyses for

- Granulometry
- Cohesion
- Angle of friction
- Proctor density
- Soil Resistivity

If the standard penetration tests give a sufficiently clear picture of the soil bearing capacity the number of test pits can be reduced.

In addition, the following soil data shall be obtained from the test pits:

- Composition and classification of the soil (sand, clay, silt, organic matter etc, soft, medium, hard, decomposed rock, rock etc.) with view to:
- Excavation
- Need to support walls of trenches
- Compacting
- Permanent or temporary groundwater (water logging)
- Hard pans below the sand (depth, thickness, type of layer)
- Clay lenses

The results of the survey, the sampling, the laboratory analyses and the calculations shall be presented in a report in **three copies** to the Engineer in Charge. The execution of the foundations shall be started only after approval of the Engineer in Charge. The contractor, however, will be responsible for design of the structures based on the results of these investigations.

5.4 Along with the excavation for the buildings and underground sump etc., the Contractor shall assess / complete the type of soil, the strata, the level of groundwater and other indicators important for structure. He has to establish soil profiles and submit these to the Engineer in Charge for approval.

- (i) Carrying out necessary Topographical Survey for all the units, pipeline etc. road works and campus development within the limits of the contract in consultation with the Engineer in Charge.
- (ii) Preparation and submission of the layout plans of entire treatment system with ancillary structures, cross sections and conceptual drawings etc. of all components of the project. The drawings must be on scales as appropriate subject to the prior approval of the Engineer in Charge.

- (iii) Additionally, he has to assess the type of soil, the strata, the level of ground water and other indicators if any and establish soil profiles and submit these to the Engineer in Charge.
- (iv) Submission of the process design, hydraulic calculations for the design of the tertiary treatment plant, interconnecting pipe, channels etc., layout and P&I diagram.
- (v) The Contractors will have a choice to make use of the data/information/reports etc. placed in this volume but the department does not stand guarantee to the data / information / reports / designs/ drawings included in this volume. The Contractors will be solely responsible for preparing and submitting required drawing after carrying out appropriate field surveys, data collection, designs etc. for approval of Engineer-in-Charge.
- (vi) Approval of all design and drawings, material to be used, equipment specifications and the samples, shall be obtained from engineer-in-charge prior to commissioning of work on site. Unless mentioned otherwise, if for any specific provision / references have been made in more than one specification, the provision more stringent shall be applicable.
- (vii) Submission of the design, specifications, catalogues and the technical data sheets of all the equipment, electrical system, design of the electrical components and the switchyard, shall be made taking into account the interfaces to the other project components /packages and the second phase of Project.
- (viii) Preparation and submission of all detailed working drawings on the basis of conceptual designs and plans approved by the Engineer in Charge.
- (ix) Providing adequately planned plinth protection works for all structures to be constructed.

List of equipment

Major components of civil and mechanical below.

5.1.1 Civil Items

For upgradation CETP:

1. Modification in Primary Clarifier converted to Clariflocculator
2. DAF feed sump and Pumps
3. Two (2) Pre DAF with accessories and dosing systems
4. Sludge sump & Pump house
5. Sludge dewatering building
6. Chemical storage and dosing building

5.1.2 Mechanical Items

For upgradation CETP:

1. Primary Clarifier converted to Clariflocculator
2. DAF feed pumps
3. Pre DAF with accessories and dosing systems
4. Surface Jet Aerators for biological treatment
5. Replacement of Glass Media filter along with underdrainage system and Activated carbon media of min. 900 iodine value
6. Sludge Transfer Pumps
7. Mechanical sludge dewatering unit (Volute press).

5. PROCESS DESIGN CRITERIA & DETAIL SPECIFICATIONS AND STANDARDS

5.1 Clariflocculator (Primary Clarifier converted to CLF)

Existing Primary Clarifier shall be converted to Clariflocculator for the Hardness removal.

The scope includes dismantling and removal of existing Primary Clarifier mechanism and SITC of proposed Clariflocculator system.

A Clariflocculator combines flocculation and clarification into a single, space-saving tank. This equipment is critical for removing hardness, suspended solids, turbidity and organic matter during wastewater treatment.

Coagulation and flocculation occur in the flocculation zone when the feed stream comes in intimate contact with chemical mixtures and suspended sludge particles from previously treated water. This contact also promotes floc growth as smaller particles agglomerate into larger heavier particles.

Effluent enters the central flocculation compartment where it is mixed with Coagulant and re-circulated precipitates.

This mixture undergoes gentle hydraulic turbulence as it passes through this zone. Part of the effluent enters the clarified zone and rises towards the effluent collector.

Settled solids shall be moved continuously along the floor towards the centre of the unit by means of a slowly rotating scraper which covers the entire floor area. The accumulated sludge is transferred to the sludge pit at the centre of the unit, reducing the total amount of solids.

Existing Primary Clarifier Structure		
Quantity	:	1 No.
Total Design flow		18.5 MLD + recycle flow / other flow
Size		32 m Dia. X 2.5 m LD
Solid concentration in clarified sludge	:	1-3%

TSS removal efficiency	:	Min. 60%
BOD removal efficiency	:	Min 25%
COD removal efficiency	:	Min 25%
Hardness removal efficiency	:	Min 75%
MOC		
Tank	:	RCC

Feed Well		MSFRP
Bridge	:	MSFRP
Rake Arm		SS 316
Center Cage	:	SS 316
Blades	:	SS 316
V-notch weir		8 MM THK FRP
Squeegees		Neoprene
Walkway	:	MSEP Chequered Plate / Grating
Handrail	:	32 NB Medium MSEP
Anchor Bolt	:	
Fasteners – Under Water	:	SS-316
Fasteners – Above Water	:	MS Galvanized

Coagulant dosing tank for Clariflocculator

Coagulant mixing tank (lime, Soda Ash etc. dosing arrangement as per contractor's design requirement) shall be constructed for this purpose. Chemical dosing tanks with pumps shall be provided to dose the coagulant for enhancing the hardness removal.

Contractor shall provide required chemical building for various chemical dosing tanks, pumps and storage area for coagulant, chemical dosing required within premises.

Chemical Dosing System for each type of chemical (lime, Soda Ash, etc.)		
Coagulant Dosing Tank		
No of dosing tank	:	2 nos. (1W + 1S for preparation)
Capacity of each tank	:	12 hrs. storage
Chemical consumption	:	As per required dose rate
Chemical Solution Strength	:	As per design
Free Board	:	0.5 m
Tank MOC	:	FRP/ HDPE
MOC of Mixer	:	SS 316 / MSRL
Dosing Pumps		
No of Pumps	:	2 nos. (1w+1s)
Type of pump	:	Diaphragm type positive displacement
Capacity of each pump	:	Max. hourly coagulant dosing requirement + 25% spare margin
MOC of pump		

Wetted parts	:	PP
Diaphragm	:	Teflon
Gland	:	PTFE
Base plate	:	MSEP

Note: Above specified dosing MOC is min. or better as recommended by manufacturer for the fluid handled / as per application.

- All dosing pumps shall be provided with VFD.

5.2 Pre –DAF Feed Tank and Pump

The Clariflocculator treated effluent collected in Pre DAF Feed tank and shall be pumped to proposed Pre-Dissolve Air Floatation unit (Pre-DAF). The sump shall be in RCC construction and having with min. 30 min. HRT for avg. flow / peak flow capacity. Min. 3 Nos. (2 working + 1 standby) pumps shall be provided to feed the effluent to DAF.

No. of Units	:	2 no.
Total Design flow	:	18.5 MLD + recycle flow / other flow
HRT	:	30 min.
Material of Construction	:	RCC M 35
Free Board	:	0.5 m
No. of Pumps	:	Min. 3nos. (2W + 1S)
Type of Pump	:	Submersible non clog
Capacity of pump	:	As per design
Head of pump	:	As per design
Material of Construction	:	
Casing	:	CI
Impeller	:	CF8M
Shaft / Shaft Sleeve	:	SS 410 / SS 410 H
VFD	:	As specified, as per Process / Design Requirement to be provided

5.3 Pre –DAF (Proposed Unit in this contract)

After Clariflocculator Effluent shall be taken to proposed Dissolve Air Floatation unit (Pre-DAF).

DAF systems are designed to remove suspended solids (TSS), Organic matter, and oils and greases (O&G) from a wastewater stream. Contaminants are removed using a dissolved air-in-water solution produced by injecting air under pressure into a recycle stream of clarified DAF effluent. This recycle stream is then combined and mixed with incoming wastewater in an internal contact chamber where the dissolved air comes out of solution in the form of micron-sized bubbles that attach to the contaminants. The bubbles and contaminants rise to the surface and form a floating bed of material that is removed by a surface skimmer into an internal hopper for further handling and Clear effluent flows out of the Pre DAF shall be conveyed to existing Biological treatment.

No. of Units	:	2 nos.
Design Flow/Unit	:	9.25 MLD + recycled flow / other flow
DAF tank MOC		RCC M-35
TSS removal efficiency	:	Min. 75%
BOD removal efficiency	:	Min 30%
COD removal efficiency	:	Min 30%
Inside diameter	:	As per design
Height of cell	:	As per design
MOC of Wetted Part	:	SS 316
MOC of Non Wetted Part	:	Epoxy painted
High pressure pumps	:	3 Nos. (2W+1S)
Capacity	:	As per design
Head	:	As per design
Air compressor	:	3 Nos. (2W+1S)
Electromagnetic Flow Meter		Inlet line of Each DAF
TSS Analyzer		Inlet and Outlet of each DAF

Coagulant dosing System for Pre DAF

Coagulant system (PAC, FeCl₃, PE etc dosing arrangement as per contractor's design requirement) shall be constructed for this purpose.

Dosing Tank		For Each Chemicals
No of dosing tanks	:	2 nos. (1W + 1S for preparation)
Capacity	:	As per design
Dose of solution	:	As per design
solution concentration	:	As per design
Operating Hrs for each tank	:	12 hrs per day
MOC of tank	:	Shall be suitable for chemical

Mixer speed	:	< 100 rpm
MOC of mixer	:	SS 316 / MSRL
Motor KW/RPM	:	As per design
Dosing Pump	:	
No. of pumps	:	Min 2 Nos. (1W+1S)
Capacity	:	As per design + 25% spare margin
Head	:	As per design
Type	:	Positive Displacement pump
MOC	:	As per pump specifications or better as recommended by manufacturer for the fluid handled / as per application
Motor kW/RPM	:	As per design

5.4 Aeration Tank (Existing)

The outlet of Pre-DAF effluent is sent to the aeration tank for biological treatment. In aeration tank bacterial culture is maintained in suspension that removes the BOD present in the incoming wastewater. In aeration tank, air is introduced through diffused aeration system along with a network of piping and blowers for oxidation.

Additional 4 Nos. of surface jet aerators shall be provided for existing biological treatment.

	Aeration Tank -1	Existing
	Size	Top - 70.0 m x 44.0 m Bottom – 52.0 m x 20.0 m
	Liquid Depth	4.7 m
	Volume of modified tank	9250 m ³
	Air Blower	Existing
	Nos. of air blower	2 (1w + 1s)
	Capacity	3400 m ³ /hr. @ 0.4 kg/cm ²
	Drive Motor	100 HP, 1500 RPM
	Nos. of air blower	2 Nos. (1W + 1S)
	Capacity	7500 m ³ /hr. @ 0.5 kg/cm ²
	Drive Motor	180 HP, 1440 RPM
	Aeration Tanks – 2&3	Existing
	No. of tanks	2 Nos.
	Size of each tank	15 m x 30 m

	LD	4 m
	Volume	1800 m ³
	Surface jet Aerators	Proposed
	No. of Unit	4 Nos.
	Capacity of each	25 HP
	MOC	SS 316

5.5 Proposed GMF Filter Feed Pumps (Proposed under this Contract)

Existing filter feed pumps, backwash system shall be utilized

5.5.1 Glass Media filter (GMF) / AFM Filter & Activated Charcol Carbon (Modify existing PSF & ACF)

The existing media of the Pressure Sand Filter (PSF) shall be replaced with Activated Filter Material (AFM) media (for filtration and support layer) to enhance filtration efficiency. The effluent flows out of existing secondary clarifier shall enter the Glass Media Filter for further treatment to remove suspended solids. Existing strainer shall be also replaced with new strainer & under drainage system.

The existing activated carbon media of the Activated Carbon Filter (ACF) shall be replaced with new Activated Carbon Media.

AFM is made of recycled crushed green glass which has the correct chemical and physical properties for activation process. AFM is hydraulically optimized in terms of grain shape and size to enhance performance. It is self-sterilized filter media with larger surface area and longer life without any chemical regeneration.

From filter, treated effluent Treated water sump for further treatment / reuse as applicable.

The dirty backwash water / drain shall be led to filter backwash tank. In case of gravity drain, required drain pit of capacity as recommended by filter vendor with required pipe up to existing backwash tank shall be provided.

No. of existing Pressure Sand Filter unit	:	9 Nos.
Size	:	3 m Dia. X 1.8 m height
Filter Media	:	

Size of media	:	Grade Wise, AFM NG Grade 1 having Min. 60-70% Ht. of Shell Ht. with Supporting media of AFM Grade 2 & AFM Grade 3 in about equal height for balance shell height
Type	:	Glass Self Sterilized
No. of existing Activated Carbon Filter unit	:	9 Nos.
Size	:	3 m Dia. X 1.8 m height

5.6 Sludge dewatering treatment (Proposed in this contract)

Chemical Sludge sump and pump

The settled sludge from pre-DAF and Clariflocculator shall be collected in proposed sludge sump. The sludge from the sludge sump shall be fed to proposed mechanical dewatering system for dewatering using positive displacement type screw pumps.

5.6.1 Chemical Sludge Sump & Pump House

The sludge sump shall be provided to collect the excess sludge from Physico –chemical process. The sump shall be equipped with coarse bubble type air grid with air blowers facilitate the mixing of contents of sludge sump. The sludge from the sludge sump shall be fed to mechanical dewatering system.

No. of sump & pump house	:	1 No.
Solid concentration	:	2 to 3 % (normal)
Specific gravity of sludge	:	1.03
Actual pumping hours for sludge Pumping	:	20 hrs./day for design flow for Volute press
Design capacity	:	Min 300 m3 volume
Hydraulic Retention Time	:	4 hrs. storage (min.)
Material of Construction		
Sump	:	R.C.C. (M-35) with water proof plaster
Pump house	:	RCC frame structure with masonry walls
Free board	:	500 mm (min.)
Top of sump	:	Min. 300 mm above FGL with hand rail
Level Transmitter	:	Required, Ultrasonic type for monitoring sludge sump level at HMI / SCADA and monitoring / operation of mechanical

		dewatering system. Low & High level alarms shall be provided at HMI.
Level Switches	:	Required - Displacer / Float type for low-low level for dry run protection of pumps associated to this sump & for alarm at HMI/SCADA.
Dewatering pump for pump house	:	Required along with level switches for auto operation & alarm
Sludge Transfer Pumps		
No. of Pumps	:	3 Nos. (2W + 1S)
Type of Pump	:	Volute press Feed: Positive Displacement type Screw Pump
Capacity of each Pump	:	Min 40 m ³ /hr.
Head of pump	:	As per hydraulic design
Pump Efficiency	:	Preferably more than 30%
Fluid Handled	:	Sludge of 2– 3% Solids Consistency
Specific Gravity	:	1.03
Solid Handling Capacity	:	40 mm Max.
Material of Construction of Pumps (Screw Pump)		
Pump Housing	:	CI IS 210 GR FG 260
Rotor/Shaft	:	Stainless Steel AISI 316 - Hard Chrome Plated
Stator	:	Nitrile Black
Sludge Mixing System		
Type of air diffuser grid	:	Coarse Bubble
Air mixing rate provided (m ³ /hr/m ³ of liquid volume)	:	1.2
Sludge Mixing Blowers		
No. of Blowers	:	2 Nos. (1W + 1 S)
Type of Blower	:	Twin lobe, Positive Displacement (Roots) Type, Air Cooled
Capacity of Each Blower	:	As per process design requirement.
Blower pressure	:	As per design
Air Mixing Rate	:	1.2 m ³ /hr./m ³ of volume of sludge sump

5.6.2 Mechanical Sludge Dewatering Device (VOLUTE PRESS) Building

The Mechanical Sludge Dewatering Device shall be Volute press type 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 dewatering device of minimum capacity as specified above or higher as per design requirements in required numbers and designed to operate for number of hours per day as specified above shall be provided.

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.

It shall have sufficient clarifying length so that separation of solids is effective. The Volute press and its accessories shall be mounted on a common Base Frame so that the entire assembly can be installed on an elevated structure.

No. of Units	:	3 Nos. (2W + 1S)
Type	:	Volute press
Capacity/Unit	:	Min 40 m ³ /hr.
Operating Hours	:	20 hrs. per day max.
Specific gravity of influent sludge	:	1.03
Solid concentration at inlet (max.)	:	1 - 2% (w/v) solids consistency or lower
Solid concentration of dewatered cake	:	20% by wt. min. dry solid basis
MOC – Wetted Parts	:	SS-316 or as per equipment specs for mechanical works
Operation of Sludge Dewatering system	:	Manual / Automatic, interlocked with Feed Pumps, Polyelectrolyte (PE) dosing Pumps operation for tripping the system in case of any failure/stoppage in associated equipment.
Hopper / Chute for sludge disposal from volute press outlet in to tractor trolley, app. 1.5-2m above GL	:	Required, constructed from SS 316
Tractor Trolleys	:	As per No. of working units of Volute press + 1 No. Spare Trolley, min. 5m ³ capacity
Tractor	:	Required, Min., 1No. for sludge and grit transportation. The tractor & tractor trolleys shall be registered in the name of client with required authorities.
Flow Measurement	:	Required, electro-magnetic flow meter on inlet line to each volute press / BFP along with metallic expansion bellows.

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 equipment. The Base Frame shall be provided with anti-vibration Pads.

A Sludge dewatering Building shall be provided near Sludge Sump & Pump House. It shall be a G (Stilt) + 1 type RCC Frame Structure. Volute press shall be installed at First Floor whereas Trucks/Trolleys/Containers shall be parked on the Ground Floor. An Electrical Hoist with Travelling Trolley of suitable capacity shall be provided. Also, it shall be provided with adequate flooring, Internal & External Plaster and Internal & External Painting. Plinth Protection shall be provided along the periphery as per specifications.

The height of sludge dewatering building room from finish ground level shall permit passage of truck underneath it plus a clearance of 1 m. The top of the platform shall be covered with RCC slab. The room shall be of sufficient size to accommodate volute press / Filter press units, polyelectrolyte dosing tank, polyelectrolyte dosing pumps, necessary pipes, fittings, valves and other electrical, mechanical and instrumentation works. It is the responsibility of the Contractor to verify and provide appropriate size of the room from operation point of view.

All the machineries shall be supported over suitable foundation. A RCC staircase of 1.2 m width with hand-railing shall be constructed to have access to platform from formation level.

Along all sides of the platform 1 m high pipe railing / brick masonry wall shall be provided.

The dewatered sludge shall be guided to trolleys providing GI/FRP chute of adequate opening. Chute shall be extended up to 1.5-2m above ground level or directed by Employer during execution.

5.6.3 Polyelectrolyte Dosing System

Polyelectrolytes shall be dozed online at the inlet of Volute press. Minimum dosage of polyelectrolyte shall be min. 1.5-2.5 Kg/Ton of dry solids in sludge at 0.1% solution strength. There shall be one Solution Preparation Tank and one Solution Dosing Tank, each suitable for minimum 8 hrs. of operation and equipped with slow speed Mixer (max. 100 RPM).

No. of Dosing Tanks	:	2 nos. (1 dosing & 1 preparation tank)
Capacity	:	Each of 8 hrs. dosing requirement
Solution strength	:	0.1% (max.)
Material of Construction of Tank	:	RCC epoxy lined
Level Switches	:	Required, one no. per tank for low level trip of tank agitator & alarm
No. of Agitator	:	1 no. per tank
Type of Agitator	:	Turbine type
MOC of Agitator	:	SS 316
Agitator Speed	:	60 – 100 RPM
No. of Dosing Pump	:	Equal to no. of mechanical dewatering device
Capacity	:	As per poly dosing requirement (min.2 Kg/MT of dry solids with at least 25% spare margin/capacity)
Type of Pump	:	Diaphragm
Pressure	:	2 kg/cm ² (Min.)
MOC:		
Wetted parts	:	PP
Diaphragm	:	Teflon
Gland	:	PTFE
Base plate	:	MSEP

Diaphragm type dosing pumps of required capacity as per design (with min. 25% spare margin) with head and quantities as specified above shall be provided to dose the required quantity of polyelectrolyte to the mechanical dewatering device. The entire construction shall be in M-35 grade reinforced cement concrete and as per IS 3370 and with epoxy lining. RCC Platform/Walkway along with RCC Staircase, minimum 1.00 m wide with 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.

Part -B General Conditions of Contract: (Annexure-1)

Name of the work:

UP-GRADATION OF 10 MLD OUT OF EXISTING 18.5 MLD CETP (ALKALINE STREAM)

1. Rate: Rates to be quoted as per Financial Bid considering costs of all required works.
2. Validity: The quoted rates and EMD must be valid for a period for 90 days from the date of closing of the tender. The overall offer for the assignment and bidder(s) quoted price shall remain unchanged during the period of validity. If the bidder quoted the validity shorter than the required period, the same will be treated as unresponsive and it may be rejected. In case the tenderer withdraws, modifies or change his offer during the validity period, bid is liable to be rejected, and the earnest money deposit shall be forfeited without assigning any reason thereof.

3. Technical Evaluation:

- (i) Detailed technical evaluation shall be carried out by JPCRf pursuant to conditions in the tender document to determine the substantial responsiveness of each tender. For this clause, the substantially responsive bid is one that conforms to all the eligibility and terms and condition of the tender without any deviation.
- (ii) The JPCRf determination of bid's responsiveness is to be based on the contents of the bid itself without recourse to extrinsic evidence. The JPCRf shall evaluate the technical bids also to determine whether they are complete, whether required sureties have been furnished, whether the documents have been properly signed and whether the bids are in order. JPCRf, Jodhpur shall have right to accept or reject any or all tenders without assigning any reasons thereof.

4. Financial Evaluation:

- (The financial bid shall be opened of only those bidders who have been found to be technically eligible. The financial bids shall be opened in presence of representatives of technically eligible bidders, who may like to be present.
5. After due evaluation of the bid(s), JPCRf will award the contract to the lowest evaluated responsive tenderer. Conditional bid will be treated as unresponsive and will be rejected.
 6. Right to issue and to accept or reject any or all tenders without assigning any reason thereof is reserved by the Competent Authority.

7. Award of Contract: The JPCRF shall consider placement of orders for jobs on those bidders whose offers have been found technical and financially acceptable. The JPCRF reserves the right to counter offer price(s) against price(s) quoted by any bidder.

8. Signing of Contract: The successful bidder shall be required to execute the Contract Agreement accepting all terms and conditions stipulated herein on a non-judicial stamp paper of Rs. 500/- (Rs. Five Hundred only) within fifteen days of the issue of the Letter of notification of award along with performance security. In the event of failure on the part of the successful bidder to sign the Contract within the period stipulated above, the EMD shall be forfeited, and the acceptance of BID shall be considered as cancelled.

9. Performance bank guarantee:

a. As a contract security for faithful performance of the contract in accordance with all the terms and conditions specified in the tender the obligations under warranty period, the successful tenderer / contractor shall furnish a Performance bank guarantee @ 5% of order value in the form of Fixed Deposit Receipt or Bank Guarantee from any Nationalized Bank duly pledged in the name of the "Jodhpur pollution Control and Research Foundation ,Jodhpur" after receipt of supply order.

b. Security Deposit @ 5% will be deducted from the consecutive running bills of the Contractor.

c. JPCRF shall have the right to encash the PBG / SD in full or part for non-compliance of any or all terms and conditions of the tender / contract and to recover any Liquid Damages and penalties under the contract as well as against defects in the any of the warranty obligations as enumerated in the tender / contract.

d. In case of part encashment, the validity of the PBG shall have to be kept valid for the remaining period as per contract, for the balance amount or for a period as required by JPCRF.

e. Refund of SD- Release of Security Deposit of the work,; It will be refunded after 12 months of successful running of the plant.

10. Authority of person signing document: A person signing the tender form or any documents forming part of the contract on behalf of another shall be deemed to warranty, that he has authority to bind such other and if, on enquiry, it appears that the person so, signing had no authority to do so, the JPCRF may without prejudice to other Civil and criminal remedies cancel contract and held the signatory liable for all cost and damages.

11. Right of acceptance: The JPCRf, reserves the right to accepting the whole or any part or portion of the bid; and the bidder shall provide the same at the rates quoted. The JPCRf reserves the right to reject any or all tenders/quotations or all offers received in response to the tender or cancel or withdraw the tender notice without assigning any reason thereof and also does not bind itself to accept the lowest quotation or any tender and no claim in this regard shall be entertained.

12. Inspection:

(a) Jodhpur Pollution Control and Research Foundation, Jodhpur shall have the right to inspect and/or to test the goods to confirm their conformity to the NIT Specifications at no extra cost to the Purchaser.

(b) Jodhpur Pollution Control and Research Foundation, Jodhpur right to inspect, test and, where necessary, reject the Goods after the goods arrival at the final destination shall in no way be limited or waived by reason of the Goods having previously been inspected, tested and passed by JPCRf , Jodhpur prior to the goods shipment.

(c) Jodhpur Pollution Control and Research Foundation, Jodhpur shall be the final authority to reject full or any part of the supply which is not confirming to the specification and other terms and conditions.

13. Right to issue and to accept or reject any or all tenders without assigning any reason thereof is reserved by the Competent Authority.

14. Rate should be quoted in Indian Rupees (INR) excluding of GST.

15. Subletting of Work: The firm shall not assign or sublet the work/job or any part of it to any other person/party or will first obtain permission in writing from the JPCRf, which will be at liberty to refuse if thinks fit. The tender is not transferable. Only one tender shall be submitted by one bidder.

16. Breach of Terms and Conditions: In case of breach of any terms and conditions as mentioned in tender, the Competent Authority, will have the right to reject the bid at any stage without assigning any reason thereof and nothing will be payable by JPCRf in that event the EMD shall also stands forfeited.

17. Insolvency etc.: In the event of the firm being adjudged insolvent or having a receiver appointed for it by a court or any other order under the Insolvency Act made against them or in the case of a company the passing any resolution or making of any order for winding up, whether voluntary or otherwise, or in the event of the firm failing to comply with any of the

conditions herein specified, JPCRf shall have the power to terminate the contract without any prior notice.

18. The taxes or any other charge if payable extra should be clearly mentioned otherwise no extra charge will be paid.

19. The items will have to be supplied at CETP site. No transportation/cartage charges will be provided for the same.

20. Bidder shall submit a copy of the tender document and corrigendum/addendum thereto, if any, with each page of this document should be signed and stamped to confirm the acceptance of the entire terms & conditions as mentioned in the tender documents.

21. After the evaluation of the bid(s), JPCRf will award the contract to the lowest evaluated responsive bidder on composite basis. Conditional bid will be treated as unresponsive and will be rejected

22. Applicable Law:

- The contract shall be governed by laws and procedures established by Govt. of India, within the framework of applicable legislation and enactment made from time to time concerning such commercial dealings/ processing.
- The contractor shall follow all the government labour laws, minimum wages, labour safety, labour insurance etc. A
- Any disputes are subject to exclusive jurisdiction of competent court and forum in Jodhpur, Rajasthan, India only.
- The Arbitration shall be held in accordance with the provision of the Arbitration and Conciliations Act, 1996 and the venue of arbitration shall be at Jodhpur. The decision of the Arbitrator shall be final and binding on both the parties.
- Force Majeure: Any delay due to Force Majeure will not be attributable to the service provider.
- No rate of escalation will be given, in any case.

23. Guarantee / Warranty Period: Bidder must provide one (01) year comprehensive on-site warranty for all the items replaced during the course of agreement and same will be started from the date of the satisfactory installation of item against any defect, workmanship and poor quality. The replaced component/s will be handed over to JPCRf.

24. Conditional tenders are liable to be summarily rejected.

25. **Site Visit** : The tenderer shall, prior to submitting his tender for the work, visit and examine the Site of works and its surroundings at his own expenses and obtain and ascertain for himself on his own responsibility all information that may be necessary for preparing his tender and entering into a contract including the actual conditions, regarding the nature, conditions of site, availability of materials, labour, probable sites for labour camps, stores etc. and extent of lead and lift required for the work in complete form over the entire duration of the Contract after taking into consideration local conditions obstructing in work, if any, and allow for all such extras likely to be incurred due to any such conditions, restrictions, obstruction etc. in the quoted Contracts Price for the work.

26. A tenderer shall be deemed to have full knowledge of the site, whether he inspects it or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed.

27. The contractor is specifically required to quote only one rate against each item. The rate Quoted for any item of material shall conform to the prescribed specifications.

28. The Tenderer is expected to examine carefully all instructions, conditions, forms, terms, technical specification, bill of quantities, and drawings in the Tender Documents, Failure to comply with the equipment's of tender submission shall be at the tender's own risk.

29. The Tenderer shall submit only as unconditional offer which complies fully with the requirements of the Tender document.

30. All tenderers are cautioned that no alternative or conditions offers, variations or deviations by the tenderers in respect of any item proposed by the tenderers shall be entertained or considered further in the process of tender approval. Furthermore, any deviation from the conditions of contract or technical specification or other requirements stipulated in the tender Document.

31. Any tender received by the JPCRF after the deadline for submission of tenders prescribed by the **JPCRF** in accordance with the foregoing will be returned unopened to the tenderer.

32. No tender shall be withdrawn in the interval between the deadline for submission of tenders and the expiry of the period of validity of tenders specified in the Tender documents. Withdrawal of a tender in any form whatsoever during this interval shall entail the forfeiture of the Earnest Money deposit without any further notice or opportunity

to the tenderer & without prejudice to any other legal rights & remedies open to the employer.

33. **Notification of Award :** Prior to the expiry of the period of tender validity prescribed by the **JPCRF** may communicate the successful bidder by email (and subsequently confirm in writing by Registered Letter) that his tender has been accepted. The Conditions of this letter shall be letter of Acceptance.

34. The letter of Acceptance will constitute the formation of the Contract and will incorporate all agreements between the parties in accordance with the form of Agreement provided in the Tender Documents.

35. After furnishing performance security by the successful tenderer in accordance with the provisions the **JPCRF** will promptly notify the unsuccessful tenderers that their tenders have been unsuccessful and discharge / returned without interest for their Tender Earnest Money Deposits.

36. The work shall conform to relevant specifications as per applicable BIS Codes.

37. In case of any defect, whatsoever is noticed in a period of **one Years** after actual completion date, the same shall be rectified by the Contractor at his own cost. The security deposit will be refunded only after **one Years** from the actual date of completion, provided that the final bill has been passed.

38. Mobilization advance shall be paid to the contractor as decided by the JPCRF (Maximum 10 % of the award value) and will be adjusted against the subsequent bills raised by the contractor.

39. **Accident liabilities:** The contractor shall be responsible for all liabilities under workman Compensation Act/ applicable act & rules.

40. **Insurance:** The contractor shall take "all contract risk insurance policy" for the work order amount of the project, "Workmen compensation policy" for all workers and labours of contractor and client working at site and "Third Party Insurance Policy" to fully cover all third party type risk. The insurance policy so taken by the contractor for such purposes shall be in the joint name of the contractor and the said policy has to be produced or has to be submitted at the time of signing of Contract agreement.

41. Extra items of work shall not vitiate the Contract. The Contractor shall be bound to execute extra items of work as directed by the Engineer Incharge. The rates for extra items will be as per rates decided under Contract Conditions.

42. **Payments**

A. **Payment for Material:**

With respect to materials and Plant brought by the Contractor to the site for incorporation in the permanent works, No claim shall be made by the Contractor unless the following conditions have been met to the Engineers satisfaction.

- i. The materials and plant are in accordance with the specifications for the works.
- ii. The materials and the plant have been delivered to the site and are properly stored and protected against loss, damage or deterioration.
- iii. The Contractors records of the requirements, orders, receipts and use of materials and plant are kept in a form approved by the Engineer, and such records are available for inspection by the Engineer.
- iv. The Contractor has submitted a statement of his cost of acquiring and delivering the materials and plant to the site, together with such documents as may be required for the purpose of evidencing such cost.
- v. The materials are to be used within a reasonable time as decided by the Engineer and the Contractor shall not unnecessarily procure any material or equipment too much in advance.

43. Concurrent penalty will imposed on the contractor in case works once taken up are delayed. This penalty should be independent of the other penalties prescribed in the contract (if any). All penalties will be governed by as per the PW , Rajasthan, norms.

44. **General RCC Works norms:**

The aggregates and cement shall be proportioned by weight only. The mixing shall always be carried out in mechanical mixer and in such a way so as to avoid any loss of water or cement. No hand mixed concrete will be allowed. It should be conveyed, placed in position and compacted by suitable type of mechanical vibrator as rapidly as practicable but in no case the time of compaction after mixing shall increase 30 minutes. Standby concrete mixer and vibrator shall be available at site.

Ordinary Portland Cement (OPC) conforming to IS: 8112-1989 mark (Grade 43/53) shall be used. Cement manufactured in mini- cement plants shall not be used. All reinforcement

used shall be TMT steel (Fe 415/ Fe 515/ Fe 550) ISI mark and shall be clean and free from loose mill scales, rust and coating of oil or other coatings which may destroy or reduce bond. Minimum size of reinforcement bars shall be of 8 mm.

Only steel shuttering shall be used. Shuttering shall be new or in a good condition without holes or dents. It has to be approved by the Engineer. The individual elements of shuttering shall be in the correct shape to ensure a gap free shuttering. Suitable systems have to be provided for keeping the shuttering in place and keeping the correct distance in case of walls. The shuttering for vertical walls of tank shall not be kept in position by removable bolts to leave holes on removal of shuttering.

The construction joints should be minimum and these have to be executed with utmost care. Before concreting on contact on joint, loose material has to be removed and they have to be cleaned properly. Honeycombing has to be avoided by suitable fixing of shuttering and proper use of vibrators.

The exposed surfaces of concrete shall be kept continuously in a wet condition by pounding or covering with a layer of sackings, canvas, Hessian or similar materials and kept continuously wet for at least 21 days from the date of placing of concrete.

To obtain dense concrete and to reduce chances of honey combing adequate admixture approved by Engineer shall be used as integral water proofing compound in concrete work. The quantity of the admixture used shall be as prescribed by the manufacturer and as approved by the Engineer.

Approved Water Proofing Compound shall be used, as per manufacturer's recommendation, for all concrete work for water retaining structures, at no additional cost to the Employer.

The Reinforced cement covers shall be designed for class AA loading duly marked on cover with adequate steel reinforcement having thickness 75 mm to 150 mm, anticorrosive bitumen painted M.S. plate, Rim and on M.S. lifting hooks, admixture like plasticizer bond-improving compound, shrinkage resistance compound abrasion resistant complete, as per approved design. The covers shall be provided in suitable Nos. and with an insertion hole of minimum 50 mm or as required.

45. Pipeline Works & Pumping Main

This specification requires reference to the following standard specifications:

IS-8329	Specification for D.I. pipes
IS:458	Specification for RCC pipes.
IS:12820	Dimensional requirements for rubber gaskets for mechanical joints and push on joint for use with cast iron pipes and fittings for carrying water, gas and sewage.
IS: 3400	Methods of test for vulcanized rubber (part-1 to 22)
IS: 5382	Rubber sealing rings for gas, mains, water mains and sewers
IS: 3624	Pressure and vacuum gauges
IS: 9862	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting.
BS: 4772	Specification for DI fittings
IS: 2062	Specification for steel for general structural purposes
IS:808	Specification for dimensions for hot rolled steel beam, column, channel and angle section
IS: 2074	Specification for ready mixed paint air drying, red oxide zinc chrome and Priming
IS:102	Ready mixed paint, brushing, red lead, non setting, Priming.
IS: 1786	Specification for high strength deformed steel bars and wires for concrete Reinforcement.
IS: 8041	Specification for rapid hardening Portland cement
IS: 12330	Specification for sulphate resisting Portland cement
IS: 5382	Rubber Sealing Rings for Gas Mains, Water Mains and Sewer. IS: 10292 Dimensional requirements for Rubber Rings.
IS: 14845	Kinetic air valve.

46. For any other items whose Specification and standards are not prescribed, shall be approved by the authorized engineer/ expert from JPCRf and his decision will be final.

47. Any information / document required for verification shall be provided by the bidder.

48. **Time of Completion of work:** 4 (four) months including monsoon excluding 1 month trial run.

49. **Defect Liability:** 12 months after commissioning.

Part-C : Technical Bid (Annexure-II)

Name of the work:

UP-GRADATION OF 10 MLD OUT OF EXISTING 18.5 MLD CETP (ALKALINE STREAM)

Special conditions of contract for qualification as detailed here under, shall be applicable in addition to all other terms and conditions already prescribed under standard agreement forms rules and regulations relating to contracts if any.

1. Applicability:

The Tender shall be on Two Stage Bidding.

2. INSTRUCTION TO BIDDERS FOR SUBMISSION OF TENDER :-

- a) The bidders who are interested in bidding can download tender documents from jpcrf.org (name of website) or can purchased by paying Rs 5000.00 (Rs Five Thousands only) from the office of the JPCRF. If tender document is downloaded then tender fee i.e Rs 5000.00 (Five Thousand) will be paid online to JPCRF Account (i.e Bank of India , Sangariya Jodhpur, A/C No ; 663620110000950, IFSC Code: BKID0006636, Type of A/C: Current, Holder Name: Jodhpur Pollution Control and Research Foundation)
- b) Bidders who wish to participate in this tender will have to pay bid document fee online (if document is downloaded) and attached the evidence of fee payment with bid.
- c) Bidder shall submit their offer both for technical and financial proposals.
- d) Before submitting the tenders, it should be ensured that all the tender papers including conditions of contract are signed by the tenderer.
- e) Tender/ bid document will be accepted offline (i.e , Hard copy only) and be reached to the office of JPCRF, Jodhpur (Rajasthan) before deadline of submission.

3. Criteria for qualifications would be as follows:

- a. The bidder should have successfully executed at least one 10 MLD or more capacity CETP/ ETP/STP construction work in the last five financial years (i.e. from 2021-22, to 2025-2026).
- b. The bidder should have achieved a financial turnover of at least **Rs 6 .00 Crore** (i.e. approx. 50% of the estimated cost of work) in any one of the last five financial years. (i.e. from 2021-22, to 2025-2026).
- c. **Litigation History:** Bidders should provide accurate information on any litigation or arbitration resulting from contract complete or under execution by him over the last

Five years and Bidder shall not be blacklisted by any Government / Semi Government/ Autonomous bodies/Trust for the execution of any construction projects/ supply of materials including machinery & equipment's.

d. The bidder shall have "AA" class registration with any of Govt. organization or registered under company act or GST Act. **No joint venture shall be allowed.**

NOTE:

For the Calculation of present price level for turnover, cost of completed work & disputed amount of similar nature, the previous year's value shall be given weight age of 10% per year as follows:

(a) For 2025-26	1.00
(b) For 2024-25	1.10
(c) For 2023-24	1.21
(d) For 2022-23	1.33
(e) For 2021-22	1.46

4. Documentation:

The bidder should furnish the following documents along with the Technical Bid.

- (a) Information regarding financial resources and capability, in Schedule-I.
- (b) Information regarding works executed in the last five financial years in Schedule – II.
- (c) Information regarding quantities executed in the last five financial years, in Schedule-III
- (d) Information regarding existing commitments & ongoing works to be completed in Schedule – IV.
- (e) Information regarding details of litigation or arbitration contracts to be furnished in Schedule – V.

Important:

(a) The bidder must ensure that all the information required in the document is furnished by him and complete in all respects. He would not be allowed to withdraw any document or to rectify any information furnished therein after submitting for the bid.

(b) The bidder should give an affidavit that the "Information furnished in Schedule I, II, III, IV, V, is correct". If any information is found to be incorrect, the offer of the bidder shall be rejected and action as per rules (PWD, Rajasthan) shall be taken.

5. Objective & Scope of work:

5.1 Objectives of the work

A. Upgradation of Existing CETP

To improve the operation and maintenance of the existing CETP system for achieving the prescribed discharge standards/norms. The Technical Proposal suggested by the JPCRF is given in the tender document for reference. The inlet and outlet parameters of textile wastewater is also given in suggested technical proposal by JPCRF. The proposal shall include:

- Scope of proposed upgradation,
- Project implementation timeline,
- Capital cost estimates

5.2 Scope of Submission

Interested parties are required to submit comprehensive techno-commercial proposals comprising:

- **Technical Proposal** (in a separate sealed envelope), and
- **Financial Proposal** (in a separate sealed envelope).

The technical proposal should clearly indicate:

- Experience in textile wastewater treatment and CETP/ZLD projects,
- Details of similar projects executed/operated,
- Proposed treatment technology and process flow,
- Implementation schedule and commissioning plan.

The financial proposal should include:

- Capital investment;

6. REJECTION OF BIDS:

- a. The JPCRf reserves the right to reject any bid, or to disqualify any or all the bidders, without assigning any reason.
- b. If a bid is not accompanied with the requisite documents mentioned in Clause 4(a) to 4(e), is not in accordance with the procedure specified in Para-2, and is not accompanied with the requisite Earnest Money (EMD), , will stand liable for rejection.
- c. Canvassing by the Bidder in any form, unsolicited letter and post tender correction may invoke summary rejection with forfeiture of EMD. Conditional tenders will be rejected. The tender receiving authority reserves the right to accept or reject any tender or all tenders without assigning any reason thereof.

SCHEDULE – I
FINANCIAL RESOURCES AND CAPABILITY
[Reference Clause 4 (a)]

1. Name of the Bidder : _____

Total financial turnover achieved by the bidder in the last five financial years.

	Year	Annual Turnover
(i)	2025-26	
(ii)	2024-25	
(iii)	2023-24	
(iv)	2022-23	
(v)	2021-22	

Note:

- Total financial turnover certificates from CA to be attached.
- Has the Bidder ever been debarred from tendering for Central Government / any Government undertaking/ trust etc.
Yes / No, if yes give details:
- Has the bidder ever been declared insolvent
Yes / No, if yes give details:
- Name / (S) and Branch (S) of Bidder's Bankers:
- Working Capital Calculation consider as on 31-03-2026.

WORKING CAPITAL

<u>S. No.</u>	<u>Item</u>	<u>Amount In Rs.</u>
1.	Current Assets as on 31-03-2026	
2.	Bank's Revolving line of credit / C.C. Limit. (If available)	
3.	Current Liabilities incl. short term Liabilities etc. Year 2025-26	
4.	Working Capital (1 + 2 - 3)	

I / We hereby certify that the above information is correct to the best of my / our knowledge and belief.

Date: -----

Signature of the authorized Signatory/ bidder

SCHEDULE – II

Experience of applicant firm in last five financial years for completion of a Civil Engineering Works

[Reference Clause 4 (b)]

Name of Bidder:

S. No.	Name of Project Contract	Project Period		Cost as per Work Order	Cost of Executed Work	Address of the employer, Name of Contact person,	Certificate of employer enclosed
		Date of Start of Work	Date of completion				
1							
1.							
2.							
3.							
4.							

Note :- Client Certificate for satisfactory completion of work from officer not below the rank of Executive Engineer or its equivalent should be attached in respect of each work. The certificate should be submitted with relevant Work Orders.

SCHEDULE – III
DETAILS OF WORKS EXECUTED DURING LAST FIVE FINANCIAL YEARS
[Reference Clause 4 (c)]

Name of Bidder:

S. No.	Name of Work (With Agreement No. & Date)	Place (District/State) & Client Name	Financial Year	Work Order Amount
1.			2025-26	
2.			2024-25	
3.			2023-24	
4.			2022-23	
5.			2021-22	

SCHEDULE – IV

DETAILS OF EXISTING COMMITMENTS & ONGOING WORKS TO COMPLETE:

[Reference Clause 4 (d)]

Name of Bidder:

S.N.	Name of work with Name of Client and Agreement Date	Financial Year	Cost of Project	Date of Completion	Value of Balance work on last date of tender submission

Signature Authorized Signatory/ Bidder

Date:

SCHEDULE – V

DETAILS OF LITIGATION OR ARBITRATION CONTRACTS

[Reference Clause 4 (e)]

Name of Bidder:

S.N.	Name of work with, Name of Client and Agreement Date	Financial Year	Cost of Project	Date of Completion	Disputed Amount claimed in Litigation/ Arbitration	Reasons for Litigation/ Arbitration

Signature Authorized Signatory/ Bidder

Date:

Affidavit

**(To be given on non-Judicial Stamp Paper of Rs 100/- only and attested by
Notary/ oath Commissioner)**

I/We Proprietor / Partner /
Authorized signatory of M/s. undertake
the oath that the information furnished by me/us in schedule I, II, III, IV, V, of the
Technical Bid for “-----” is correct to the best of my / our knowledge. If
any information is found to be incorrect JPCRFB Jodhpur has right to reject the Bid
and to take action against me/us as per rules.

.....
Proprietor/Partner/Authorized
Signatory
.....

Part -D FINANCIAL BID (Annexure-III)

Name of the work:

UP-GRADATION OF 10 MLD OUT OF EXISTING 18.5 MLD CETP (ALKALINE STREAM)

1. General Information:

Estimated Cost	Earnest Money (2 % of Estimated cost)	Tender Fee	Scheduled Period of Completion
1200 Lakhs (INR)	24 Lakhs (INR)	5000.00 (INR)	4 Months from the date of Issue of work order

Date & Time of Bidding Document Download / sale	Date & Time of Bid Submission	Date & Time of Opening (Technical-Bid)	Date & Time of opening (Financial-Bid)
08-7-2026, 11.30 AM to 13-7-2026 Upto 3.00 PM	14-07-2026, 3.00 PM	14-07-2026, 4.00 PM	14-07-2026, After evaluation of technical bid.

- 1- Tender document, EMD & Tender Fee is to be deposited online / by DD and receipt is to be Attached (if deposited online) and attach D.D., with technical Bid.
2. The Tender can be downloaded from web site web site of JPCRF (www.jpcrf.org)

Conditions:-

- 1- All Survey work & Design will be done by contractor and will be submitted by contractor to the JPCRF after technical approval from JPCRF, the contractor can start the execution work at site.
- 2- The design in Technical Proposal (Part-A) is tentative and may vary as per the actual drawing & design submitted by the contractor to the competent authority
3. Cost of Electricity Consumption/Diesel will be paid by Contractor, but supply and generator facility will be provided by the JPCRF.

Format for Rate quotation:

Bidders are required to fill up all blank spaces in this Bid Form

To

Jodhpur Pollution Control & Research
Foundation, Jodhpur (JPCRF)
SP-1, Sangaria Industrial Area,
Sangaria, Jodhpur

SUB : Engineering, Procuring, providing, Constructing, Installing, Commissioning (EPC) and conducting successful trial run and acceptance test for upgradation of 10 MLD out of Existing 18.5 MLD Capacity CETP for JPCRF, Jodhpur with all Contingent Civil, Mechanical and Electrical equipment and accessories, Instrumentation including miscellaneous works etc. complete.

We have examined the Conditions of Contract, Employer's Requirements, Schedules, Addenda Nos. _____ and the matters set out in the Appendix hereto. We have understood and checked these documents and have not found any errors in them. We accordingly offer to design, execute commission the said works, conducting successful trial run, acceptance test and remedy any defects, fit for purpose in conformity with these documents and the enclosed Proposal, for the fixed lump sum of Rs. _____ or other such sums as may be determined in accordance with the terms and conditions of the Contract. The above amounts are in accordance with the Price Schedules herewith and are made part of this bid.

We confirm our agreement with the appointment of Dispute Adjudication Board of General Condition of Contract.

We agree to abide by this Bid until 60 days and it shall remain binding upon us and maybe accepted at any time before that date. We acknowledge that the Appendix forms part of our Bid.

If our bid is accepted, we will provide the specified performance security, commence the Works as soon as reasonably possible after receiving the Employer's Representative's notice to commence, and complete the Works in accordance with the above-named documents within the time stated in the Appendix to Technical Proposal.

Unless and until a formal Agreement is prepared and executed, this Bid, together with your written, acceptance thereof, shall constitute a binding contract between us.

We understand that you are not bound to accept the lowest or any bid you may receive.

We are, Gentlemen

Yours faithfully

Signature _____ in the capacity of _____ duly authorized
to sign bids for and on behalf of

Address

Date _____

APPENDIX TO PRICE PROPOSAL

APPENDIX TO PRICE PROPOSAL

Conditions of Contract

Employer's name and address		Director, Jodhpur Pollution Control & Research Foundation, Jodhpur SP-1, Sangaria Industrial Area, Sangaria, Jodhpur Rajasthan
Contractor's name and address		_____ _____ _____ _____ _____
Phone No. :		
Fax No. :		
E-mail :		
Time for notice to commence		7 Days
Name and address of the Employer's Representative/ Engineer		To be nominated by Employer at the time of Award of Contract
Language for communications		English
Electronic transmission systems		
Confidential Details		_____ _____ _____ _____ _____ _____
Currency of all payments		Indian Rupees
Amount of insurance for work		Total cost of work
Amount of third party insurance		As per law per occurrence, number of occurrences: maximum three
Periods for submission of insurance		
Evidence of insurance		30 days from commencement date
Relevant policies		60 days -do-

Number of members of Arbitral Tribunal		
Members of Dispute Adjudication Board (if not agreed) to be nominated by	}	As per the Arbitration and Conciliation Act 1996, India along with its latest amendments.
Arbitration rules		
Language of arbitration		English
Place of arbitration		Jodhpur, Dist.-Jodhpur Rajasthan, India
Procedural Law		Indian as governed by the Arbitration and Conciliation Act, 1996, India and its latest amendments.
Limit of Retention Money		10% of the construction contract price. (5% S.D. + 5% to be recovered from bill)
Payments in Local Currencies		In Indian Rupees
Time for access to the Site		Within 15 days from the date of Letter of Work Order Acceptance / Letter of Intent
Amount of performance security		5% of contract price
Damages for delay		0.5% / week with limit of 10% of construction cost
Deductions	:	All deductions shall be as per prevailing state/central government rules & regulations.

PRICE SCHEDULE - A : PRICE GRAND SUMMARY

Sr. No.	Item	Rate offered in	
		Figures	Words
I	Construction Phase: Complete design, supply, erection and Commissioning (EPC) Upgradation of 10 MLD out of existing 18.5 MLD capacity CETP for JPCRF, JODHPUR along with all related Mechanical and Electrical equipment and accessories, Instrumentation including miscellaneous works etc. complete (Bidder to fill up Price Schedule-B for Broad Unit wise Break-up) Total Price Excluding GST of (I), in Rs.		
	GST in Rs.		
	GRAND TOTAL (INCLUDING GST) in Rs.		

Signature of Contractor :

Name :

Company's Seal :

Date :

PRICE SCHEDULE - B : SUMMARY OF SCHEDULE OF PRICE

(CONSTRUCTION PHASE)

Sr. No.	Item Description (Upgradation of CETP as per scope of work)	Rate offered in Rs. Excluding GST	
		Price in Figure	Price in Words
1.	Civil Works		
2.	Piping works		
3.	Mechanical works		
4.	Electrical works		
5.	Instrumentation works		
6.	Trial run, Testing & commissioning of entire plant etc. complete.		
	Total Price in Rs. (1 + 2 + 3 + 4 + 5 + 6)		

Note: 5% amount of all running bills shall be recovered and kept in deposit till the successful completion of the Defect Liability Period.

Signature of Contractor :

Name :

Company's Seal :

Date :

SCHEDULE – D BREAK UP OF PAYMENT SCHEDULE

PREAMBLE

1. As mentioned in the Conditions of contract, the Contract being a lump sum type turnkey Contract on EPC basis, the provision of measurement will be applicable only for the assessment of value of work done for inclusion in any interim certificate for part payment to the Contractor.
2. The Schedule specifies the procedure for all such assessment of the items for Civil/Mechanical/Electrical/Instrumentation works specified in Schedule B.
3. Each item of Schedule B has been divided into broad components. The Employer's Representative shall assess the value of each component as indicated in paragraph 6 herein below.
4. Percentages are indicated against each component of each item of Civil Mechanical/Electrical/Instrumentation works specified in Schedule B, based on the Employer's best appreciation of the value of the component as related to the total costs of the concerned item as whole. A head titled (any other unforeseen work(s) / item(s)) is included in each breakdown of schedule and **the tenderer shall at the time of tendering indicate any additional items which he considers necessary but cannot be covered by any of the heads indicated in the breakup.**
5. The percentage breakup as indicated in the Schedule may differ from that corresponding to the tenderer's scheme and design and he should take this into account while quoting his lump sum prices for the items specified in Schedule-B
6. The contractor shall, **after approval of his detailed hydraulic as well as structural designs and drawings, furnish to the Employer's Representative an initial bill of quantities to all major items, to be reviewed and updated periodically with the Employer's Representative.** This bill of quantities will be used **for assessment of percentage progress of the component at any stage.** By measurement jointly taken by the Employer's Representative and the Contractor, **mutually agreed and entered in the measurement books in the form and by the method approved by the Employer's Representative, and signed jointly by both the parties**
7. Bidders shall give the required details and a breakdown of their prices and GST applied for each item during the payment on running bills & final bill for the capital work.

Income Tax as per the prevailing applicable rates at that time shall be deducted from all the payments to be made and necessary Tax Deduction certificate will be provided in due course of time.
8. The payment on running bills & final bill will be regulated as per percentage shown in each item.

SCHEDULE OF MILESTONE PAYMENT

PRICE SCHEDULE D1: MILESTONE PAYMENT BREAKUP FOR CIVIL WORK AS SPECIFIED

No.	Items	% Milestone Payment
1.	On completion of all civil work comprises of excavation, PCC, Raft/footing wall / super structure plastering and all finishing work (new structure) and also Empty Sump /tanks, clean and plastering and all finishing work (existing structures).	80%
2.	On completion of the water tightness test/completion of work	10%
3.	On successful testing & commissioning	5%
4.	On successful completion of PG test	5%
		100%

PRICE SCHEDULE D2: MILESTONE PAYMENT BREAKUP FOR PIPING, MECHANICAL, ELECTRICAL & INSTRUMENTATION WORKS ALONG WITH SPARES AS SPECIFIED

No.	Items	% Milestone Payment
1.	On supply of equipment, pipes, specials, valves, accessories, instruments etc. including spares at site, after inspection, along with literature, drawings, operating pamphlets, manual etc. as required.	75%
2.	On erection of all equipment, pipes, specials, valves, instruments and necessary accessories including installation of mechanical / electrical / instrumentation system / equipment, cabling, etc. complete.	15%
3.	On successful testing & commissioning	5%
4.	On successful completion of PG test	5%
		100%

Note: %age total cost means cost quoted in schedule B and finally approved by the employer.

Signature of Contractor:

Name :

Company's Seal :

Date :

7.0 Civil Specifications:

CIVIL AND BUILDING WORKS

Design Submissions

- 1.1.1 Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to EMPLOYER. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by EMPLOYER.
- 1.1.2 The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

Design Standards

- 1.2.1 All designs shall be based on the latest Indian Standard (I.S.) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by EMPLOYER. In case of any variation or contradiction between the provisions of the I.S. Standards or Codes and the specifications given along with the submitted tender document, the provision given in this Specification shall be followed.
- 1.2.2 All reinforced concrete structural design shall generally conform to the following publications of the Indian Standards Institution :

I.S. 456	Code of Practice for plain and reinforced concrete	
I.S. 875	Code of Practice for design loads for buildings and structures	(
	Part 1 to 5)	
I.S. 3370	Code of Practice for concrete structures for the storage of liquids	
	(Part I to IV)	
I.S. 1893	Criteria for earthquake resistant design of structures	
I.S. 2974	Code of Practice for design and construction of machine foundations	
	(Part 1 to 4)	
- 1.2.3 All structural steel design shall generally conform to the following publications of the Indian Standards Institution :

I.S. 800:	Code of Practice for general construction in steel	
I.S. 806:	Code of Practice for use of steel tubes in general building construction	

Design Life

The design life of all structures and buildings shall be 60 years.

Design Loading

All buildings and structures shall be designed to resist the worst combination of the following loads / stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads, impact load and other specific loads.

1.4.1 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery.

The following minimum loads shall be considered in design of structures :

- | | | | |
|-------|---|---|--|
| (i) | Weight of water | : | 9.81 kN/m ³ |
| (ii) | Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered. | : | 20.00 kN/m ³ |
| (iii) | Weight of plain concrete | : | 24.00 kN/m ³ |
| (iv) | Weight of reinforced concrete | : | 25.00 kN/m ³ |
| (v) | Weight of brickwork (exclusive of plaster) | : | 22.00 N/m ² per mm thickness of brickwork |
| (vi) | Weight of plaster to masonry surface | : | 18.00 N/m ² per mm thickness |
| (vii) | Weight of granolithic terrazzo finish or rendering screed, etc. | : | 24.00 N/m ² per mm thickness |

1.4.2 Live Load

Live loads shall be in general as per I.S. 875. However, the following minimum loads shall be considered in the design of structures:

- | | | | |
|-------|--|---|-------------------------|
| (i) | Live load on roofs (accessible) | : | 1.50 kN/m ² |
| | (Non-accessible) | : | 0.75 kN/m ² |
| (ii) | Live load on floors supporting equipment such as pumps, blowers, compressors, valves, etc. | : | 10.00 kN/m ² |
| (iii) | Live load on all other floors walkways, stairways and platforms. | : | 5.00 kN/m ² |

In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of EMPLOYER prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during

maintenance or erection / construction shall be considered and shall be partial or full whichever causes the most critical condition.

1.4.3 Wind Load

Wind loads shall be as per I.S. 875.

1.4.4 Earthquake Load

This shall be computed as per I.S. 1893. An importance factor appropriate to the type of structure shall be considered for design of all the structures.

1.4.5 Dynamic Load

Dynamic loads due to working of items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of structures as per manufacturer's data.

Joints

1.5.1 Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for all walls and rafts.

1.5.2 Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in all walls, floors and roof slabs of water retaining structures.

1.5.3 Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2-m height. PVC waterstops of 150 mm width shall be used for walls and 230 mm width for base slabs.

1.5.4 Expansion joints for non liquid retaining structures shall be provided as per IS 3414.

Design Conditions for ESR, Underground or Partly Underground Liquid Retaining Structures.

1.6.1 All underground or partly underground liquid containing structures shall be designed for the following conditions :

- (i) liquid depth to be considered up to full height of wall and no relief due to soil pressure from other side to be considered.
- (ii) structure empty condition (i.e., empty of liquid, any material, etc.) : full earth pressure with saturation and surcharge pressure wherever applicable, to be considered.
- (iii) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall.
- (iv) partition wall between two compartments : to be designed as one compartment empty and other full for both the directions.
- (v) structures shall be designed for uplift in empty conditions with no live load with the appropriate water table.
- (vi) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilisation and dynamic water loads.
- (vii) underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with

Tender for Up-gradation of 10 MLD out of existing
18.5 MLD CETP

appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation.

Foundations

- (i) The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be as per IS 1904.
- (ii) Maximum safe bearing capacity of soil strata shall be taken as indicated in geotechnical reports.
- (iii) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by EMPLOYER.
- (iv) Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slab shall be designed for uplift forces due to ground water pressure.
- (v) Where there is level difference between the natural ground level & the foundations of structure or floor slabs, this difference shall be filled up in the following ways:
 - In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm.) and the level difference shall be made up by compacted backfill as per specifications. However the thickness of each layer shall not exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction. The safe bearing capacity of this well compacted backfilled soil shall not exceed 100 kN/sq.m.
 - In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete (1:5:10)

Design Requirements

- 1.8.1 The following are the design requirements for all reinforced or plain concrete structures :
- All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade 1 : 2 : 4.
- a) All structural reinforced concrete for water retaining structures shall be of a minimum M35 grade with a maximum 20 mm aggregate size for footings and base slabs and all other structural members. For non water retaining structures the concrete shall be of M 25 grade. The structures shall have to be designed as per IS : 3370 (Part I-IV).
 - b) The reinforced concrete for water retaining structures shall have a minimum cement content of 380 kg/m³ with a maximum 20 mm size aggregate and 330 kg/m³ with a maximum 40 mm size aggregate as per IS : 3370 (Part I-IV).
 - c) The minimum reinforcement for water retaining structures in each direction should be 0.35% of cross section. The minimum clear cover to all reinforcement including stirrups and links shall be 50 mm for all water retaining structures.
 - d) All buildings shall have a minimum 1 metre wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.
 - e) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.
 - f) The bridges & bridge supporting structures shall be designed to safely withstand the loading.

- g) All pipes & conduits laid below the structural plinth & road works shall be embedded in reinforced concrete of grade M15 of minimum thickness 150 mm.
- h) Approved quality water proofing compound (chloride free) shall be added during concreting of all liquid containing structure in the proportions specified by manufacturer or 2 % by weight of cement whichever is higher.
 - The wall and floor panels shall be poured in sequential order with a minimum time gap of 4 days.
- i) All water retaining structures shall be constructed in OPC cement. Cement as per IS specification.
- j) Design of water retaining structure shall be as per IS:3370.

The following minimum thickness shall be used for different reinforced concrete members, irrespective of design thickness:

(i) Walls for liquid retaining structures	:	200 mm
(ii) Channel / Launder	:	150mm
(iii) Roof slabs for liquid retaining structures (other than flat slabs)	:	150 mm
(iii) Bottom slabs for liquid retaining structures	:	150 mm
(iv) Floor slabs including roof slabs, walkways, canopy slabs	:	125 mm
(v) Walls of cables / pipe trenches, underground pits etc.	:	125 mm
(vi) Column footings	:	300 mm
(vii) Parapets, chajja	:	100 mm
(viii) Precast trench cover	:	75 mm

Materials in General

- 1.9.1 The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.
- 1.9.2 Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.
- 1.9.3 All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.
- 1.9.4 As soon as practicable after receiving the order to commence the Works, the Contractor shall inform EMPLOYER of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of EMPLOYER which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep EMPLOYER informed of orders for and delivery dates of all materials.
- 1.9.5 Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

Samples and Tests of Materials

- 1.10.1 The Contractor shall submit samples of such materials as may be required by EMPLOYER and shall carry out the specified tests directed by EMPLOYER at the Site, at the supplier's premises or at a laboratory approved by EMPLOYER. EMPLOYER may appoint separate third party inspection for the material testing to ensure the quality of the work. The Contractor shall replace the defective material as an outcome of these tests.
- 1.10.2 Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by EMPLOYER.
- 1.10.3 The Contractor shall give EMPLOYER seven days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by EMPLOYER. Representative of EMPLOYER shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by EMPLOYER to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to EMPLOYER's Representative within seven days of every test such number of certified copies (minimum six) of the test results as EMPLOYER may require.
- 1.10.4 Approval by EMPLOYER as to the placing of orders for materials or as to samples or tests shall not prejudice any of EMPLOYER's powers under the Contract.
- 1.10.5 The provisions of this clause shall also apply fully to materials supplied under any nominated sub-contract.

Standards

- 1.11.1 Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.
- 1.11.2 Where the relevant standard provides for the furnishing of a certificate to EMPLOYER, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to EMPLOYER.
- 1.11.3 The specifications, standards and codes listed below are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.
- 1.11.4 In case of discrepancy between the Bid Specification and the Standards referred to herein, the Bid Specification shall govern.

a) Materials

IS : 269	Specification for 33 grade ordinary Portland cement
IS : 383	Specification for coarse and fine aggregates from natural sources for concrete
IS : 428	Specification for distemper, oil emulsion, colour as required
IS : 432	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)
IS : 455	Specification for Portland slag cement

IS : 458	Specification for precast concrete pipes(with and without reinforcement)
IS : 650	Specification for standard sand for testing of cement
IS : 651	Specification for salt glazed stoneware pipes and fittings
IS : 777	Specification for glazed earthenware tiles
IS : 808	Specification for dimensions for hot rolled steel beam, column, channel and angle sections
IS : 814	Specification for covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel
IS : 1003	Specification for timber paneled and glazed shutters(Parts 1 & 2)
IS : 1038	Specification for steel doors, windows and ventilators
IS : 1077	Specification for common burnt clay building bricks
IS : 1398	Specification for packing paper, water proof, bitumen laminated
IS : 1489	Specification for Portland pozzolana cement (Parts 1 & 2)
IS : 1566	Specification for hard drawn steel wire fabric for concrete reinforcement
IS : 1580	Specification for bituminous compounds for water proofing and caulking purposes
IS : 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 1852	Specification for rolling and cutting tolerances for hot rolled steel products
IS : 1948	Specification for aluminium doors, windows and ventilators
IS : 1977	Specification for structural steel (ordinary quality)
IS : 2062	Specification for steel for general structural purposes
IS : 2185	Specification for concrete masonry units (Parts 1 & 2)
IS : 2202	Specification for wooden flush door shutters (Parts 1 & 2)
IS : 2645	Specification for integral cement water proofing compounds
IS : 2750	Specification for steel scaffoldings
IS : 2835	Specification for flat transparent sheet glass
IS : 3384	Specification for bitumen primer for use in waterproofing and damp roofing
IS : 3502	Specification for steel chequered plates
IS : 4021	Specification for timber door, window and ventilator frames
IS : 4350	Specification for concrete porous pipes for under drainage
IS : 4351	Specification for steel door frames
IS : 4990	Specification for plywood for concrete shuttering work
IS : 8112	Specification for 43 grade ordinary Portland cement
IS : 9862	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS : 10262	Recommended guidelines for concrete mix design
IS : 12269	Specification for 53 grade ordinary Portland cement
IS : 12330	Specification for sulphate resisting Portland cement
IS : 12709	Glass fibre reinforced plastics (GRP) pipes, joints and fittings for use for potable water supply

b) Tests

IS : 516	Method of test for strength of concrete
IS : 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS : 1199	Methods of sampling and analysis of concrete
IS : 2386	Methods of test for aggregates for concrete(Parts 1 to 8)
IS : 2720	Methods of test for soils (Parts 1 to 39)
IS : 3025	Methods for sampling and test (physical and chemical) for water and wastewater (Parts 1 to 44)
IS : 3495	Method of test for burnt clay building bricks(Parts 1 to 4)
IS : 3613	Acceptance tests for wire flux combination for submerged arc welding

IS : 4020	Methods of tests for wooden flush doors Type tests
IS : 4031	Methods of physical tests for hydraulic cement (Parts 1 to 15)
IS : 5807	Method of test for clear finishes for wooden furniture (Parts 1 to 6)
IS : 7318	Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)

c) Codes of Practice

IS :456	Code of practice for plain and reinforced concrete
IS : 783	Code of practice for laying of concrete pipes
IS : 800	Code of practice for general construction in steel
IS : 806	Code of practice for use of steel tubes in general building construction
IS : 816	Code of practice for use of metal arc welding for general construction in mild steel
IS : 817	Code of practice for training and testing of metal arc welders
IS : 875	Code of practice for design loads (other than earthquake) for building structures(Parts 1 to 5)
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminum) doors, windows and ventilators
IS : 1172	Code of practice for basic requirements for water supply, drainage and sanitation
IS : 1477	Code of practice for painting of ferrous metals in buildings (Parts 1&2)
IS : 1597	Code of practice for construction of stone masonry (Parts 1 &2)
IS : 1742	Code of practice for building drainage
IS : 1893	Criteria for earthquake resistant design of structures
IS : 2065	Code of practice for water supply in buildings
IS : 2212	Code of practice for brickwork
IS : 2338	Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
IS : 2394	Code of practice for application of lime plaster finish
IS : 2395	Code of practice for painting, concrete, masonry and plaster surfaces (Parts 1 & 2)
IS : 2470	Code of practice for installation of septic tanks (Parts 1 & 2)
IS : 2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS : 2571	Code of practice for laying in situ cement concrete flooring
IS : 2595	Code of practice for radiographic testing
IS : 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
IS : 2974	Code of practice for design and construction of machine foundations (Parts 1 to 4)
IS : 3114	Code of practice for laying of Cast Iron pipes
IS : 3370	Code of practice for concrete structures for the storage of liquids (Parts 1 to 4)
IS : 3414	Code of practice for design and installation of joints in buildings
IS : 3558	Code of practice for use of immersion vibrators for consolidating concrete
IS : 3658	Code of practice for liquid penetrant flaw detection
IS : 3935	Code of practice for composite construction
IS : 4000	Code of practice for High strength bolts in steel structures
IS : 4014	Code of practice for steel tubular scaffolding (Parts 1 & 2)
IS : 4111	Code of practice for ancillary structures in sewerage system (Parts 1-4)
IS : 13920	Code of practice for laying of glazed stoneware pipes

IS: 4326	Code of practice for Earthquake Resistant Design and Construction of Buildings
IS : 4353	Recommendations for submerged arc welding of mild steel and low alloy steels
IS : 5329	Code of practice for sanitary pipe work above ground for buildings
IS : 5334	Code of practice for magnetic particle flaw detection of welds
IS : 5822	Code of practice for laying of welded steel pipes for water supply
IS : 7215	Tolerances for fabrication of steel structures
IS : 9595	Recommendations for metal arc welding of carbon and carbon manganese steels
IS : 10005	SI units and recommendations for the use of their multiples and of certain other units

d) Construction Safety

IS : 3696	Safety code for scaffolds and ladder (Parts 1 & 2)
IS : 3764	Safety code for Excavation work
IS : 7205	Safety code for erection of structural steel work

Orientation

1.12.1 The works shall be laid out within the confines of the Site in order to interface to the existing infrastructure of roadways and inlet and outlet pipework . Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of EMPLOYER, be relocated by the Contractor.

Buildings and Structures

1.13.1 All the building and structure works shall generally comply with the following EMPLOYER's requirements unless otherwise specified elsewhere.

All building works shall be of reinforced concrete framework.

All external walls shall be in 230 mm thick brick masonry built cement mortar in 1:4. Transoms and mullions of 115 mm x 230 mm size with four numbers 6 mm bars and 6 mm links at 150 mm c/c shall be provided to form panels not exceeding 3500 mm x 3500 mm in size.

All internal partition walls except for toilets and Residential units shall be in 230 mm thick brick masonry built in cement mortar 1:4 with transoms and mullions as in (2) above. Toilet partition walls shall be in 115 mm thick brick masonry built in cement mortar 1:4 and shall have transoms and mullions as in (2) above and shall form panels not exceeding 1200 mm x 1200 mm in size.

(a) Finishes to concrete liquid retaining structures (for details, refer clause 3.16 of this volume) shall be :

F1	-	External surfaces, buried
F2	-	External surfaces exposed and up to 300 mm below ground level
F2	-	Internal surfaces

(b) Finishes to other concrete structures (for details, refer clause 3.16 of this volume) shall be :

F1	-	Buried
F1	-	Exposed, where plastering is specified
F2	-	Exposed

4. All internal masonry surfaces finish shall have 15 mm thick plain faced cement plaster in cement mortar (1:4) with neat lime or neeru finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.
5. All external masonry surfaces shall have 20 mm thick sand faced cement plaster in cement mortar (1:3) in two coats. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.
6. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.
7. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.
8. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.
9. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.
10. The flooring in all areas except toilets and staircases shall be of vitrified tiles of first class quality. Half tile skirting shall also be provided in these areas.
11. Toilet areas shall have 450 mm x 450 mm x 25 mm thick polished marble Kota stone tiles placed in cement mortar or lime mortar to give an overall thickness of 50 mm. 2200 mm high ceramic tile (size 200 mm x 200 mm x 6 mm thick) dado placed in cement mortar shall also be provided in these areas. In W.C. areas, the flooring and 2200 mm high dado shall be provided with 200 mm x 200 mm x 6 mm thick coloured ceramic tiles.
12. All staircases shall have 25 mm thick chequered mosaic tiles for treads and 25 mm thick plain mosaic tiles of approved shade for risers set in cement mortar or lime mortar to give an overall thickness of 50 mm.

Stairways shall be provided to permit access between different levels within buildings. All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical ladders fitted with landing point extensions will be permitted where considered appropriate by the EMPLOYER to access areas not frequently visited.

13. All floor cut-outs and cable ducts, etc. shall be covered with precast concrete covers in outdoor areas and mild steel chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with GI hand railing of 32 NB (M).
14. All staircases shall be provided with 32 NB (M) galvanised pipe hand railing for protection.
15. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W downtake inlet points.
16. For roofing drainage, cast iron rainwater downtakes with 110 mm dia guPVC 6kg/sqcm pipe and C.I. grating at top shall be provided. For roof areas up to 100 sq.m minimum two nos. 100 mm diameter downtake pipes shall be provided. For every additional area of 100 sq.m or part thereof, at least one no. 100 mm dia. downtake pipe shall be provided.
17. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. Chajjas, canopies and roof projections shall have drip moulds.
18. Building plinth shall be minimum 600 mm above average finished ground level around building.
19. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building.
20. All windows and ventilators shall have 25 mm thick marble stone sills bedded in cement mortar (1:3)
21. All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with handrailings.
22. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act.
23. All rooms in the buildings shall be provided with appropriate sign boards indicating the function of the rooms involved.
24. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry in the form of EOT / HOT crane shall be provided. Minimum capacity of 2 tonnes or more as required shall be provided for monorail.
25. The design of buildings shall be suitable for the climatic conditions existing on site. Buildings shall as far as is possible permit the entry of natural light.
26. Emergency exit doorways with Signboards shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

27. The side walls of buildings shall, comprise at least 15% ventilated brickwork or louvers. Ventiladed brickwork or louvers shall not be used where the ingress of driven rain could affect equipment or stored materials.

Roadways, & Pathways

- 1.14.1 A comprehensive network of roadways shall be provided around the structures to link in with the existing road network and permit access to the units for necessary maintenance, delivery of consumables and personnel access. All roads shall be of asphalt macadam and minimum 5 metres wide. Vehicular access shall be provided for all Plant structures and buildings. All roads shall be provided with drainage and shall be constructed to prevent standing water.

Site Drainage

The contractor shall provide a site drainage system which shall comprise of the Storm Water Drainage and Foul Drainage.

1.15.1 Storm Water Drainage

Storm water drains adjacent to the existing and proposed roads (under this Contract) shall be sized for a rainfall intensity of 80 mm/hr, allowing for 100% runoff. Drains adjacent to roads shall be in brick masonry (1:5) of appropriate thickness, topped with 75 mm thick M 15 precast concrete covers and plastered internally in cement mortar (1:4), 20 mm thick.

The storm water drainage system shall be designed to cater for the run-off from the structures, if necessary.

1.15.2 Foul Drainage

The foul drainage system shall accept discharge from toilets, washrooms, offices and shall discharge to separate septic tank and further to a soak pit, both of appropriate volumes for individual buildings.

Cable and Pipework Trenches

- 1.16.1 Cable and pipework trenches shall generally be constructed in reinforced concrete. However, 500 mm x 500 mm size or smaller trenches, not on fill may be constructed in 350 mm thick brick masonry (1:4). The trenches will be plastered internally with cement mortar (1:4) and externally in cement mortar (1:3).
- 1.16.2 Trenches within the buildings or Plant areas shall be covered with M.S chequered plates, suitably painted and those outside the buildings shall be covered with M20 precast R.C.C covers. The trenches shall be suitably sloped to drain rain water.
- 1.16.3 Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of EMPLOYER while planning the works.

Pipes and Ducts

- 1.17.1 R.C.C ducts for drainage shall have minimum 1 metre cover while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.
- 1.17.2 All drains (except storm water drains adjacent to roads) shall be covered and designed structurally for appropriate loads.

Valve Chambers

All valve chambers are to be of an adequate size to facilitate maintenance and operation. The base slab of valve chambers shall slope towards a sump pit from which water can be pumped to keep the chamber dry. All valve chambers shall be constructed in M20 grade reinforced concrete. Chambers shall have removable reinforced concrete covers, as appropriate, approach ladders and valve supports.

Landscaping

- 1.19.1 The CETP plot site shall be landscaped once the Works are substantially complete. The landscaping scheme shall be submitted and got approved from EMPLOYER prior to start of actual work.
- 1.19.2 Landscaping shall include planting of suitable trees and development of grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected. Medicinal and fruit trees shall be avoided.

1.19.3 Tree Planting

Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with top soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh shall be provided.

Security Fencing and Gates

- 1.20.1 Security fencing for the CETP plot complex and associated works shall be of 2000mm high with 230/350 mm thick brick/random rubble masonry, in cement mortar (1:6), with recessed pointing in cement mortar (1:3), on both the faces. There shall be concrete coping over brick/random rubble masonry wall and 750 mm high barbed wire fencing above it.
- 1.20.2 Substation shall have internal fencing as per Electricity Board guidelines.
- 1.20.3 4.5m wide x 2.2m high main steel gates and 1m wide x 2.2 m high steel wicket gate made out of tubular sections/square bars/flats of welded construction alongwith the locking arrangement and posts to match with security fencing shall be provided at appropriate places. Gates shall be painted with similar synthetic enamel paint.

- 1.20.4 Chain link fencing with gates around electrical installations shall be provided as per Electricity board of Rajasthan's requirements.

DETAILED SPECIFICATIONS CIVIL WORKS

1.0 Clearing The Sites :

- 1.1 The site at which the construction is to be done and the areas required for setting out and other operations shall be cleared of all obstructions, loose stones, and rubbish of all kinds, stumps of trees, C.I. Pipes, R.C.C. Pipes, brushwood as well as all trees shall be removed as directed. The roots shall be entirely grubbed up.
- 1.2 The products of the clearing to be stacked in such a place and in such a manner as directed by Engineer-in-charge.
- 1.3 In site clearing all trees not specified for preservation, bamboos, jungle wood and brushwood shall be cut down and their roots grubbed up. All wood and materials from the clearing shall be the property of CLIENT and shall be arranged as directed by the Engineer-in-charge or his authorized agent. The materials found to be useful by the Engineer-in-charge shall be conveyed and properly stacked as directed within the specified limit.

Useless materials will be burnt or otherwise disposed off as directed.

- 1.4 All holes or hollows, whether originally existing or produced by digging up roots, shall be carefully filled up with earth, well rammed and leveled off, as may be directed.
- 1.5 The contractor shall have to dismantle the existing concrete / steel structure obstructing in construction area above as well as below ground shall be removed and cleared of as directed.
- 1.6 The contractor shall have to visit the site and familiarize themselves thoroughly with the site condition and all obstruction in construction of treatment plant before submitting the tender and shall have to quote the tender accordingly.
- 1.7 During excavation if any obstruction like pipe/cable are found, the same should be shifted as directed by the Engineer-in-charge.
- 1.8 No extra charge will be paid for removing any kind of obstructions.

2.0 Excavation :-

The excavation in foundation shall be carried out in true line and level and shall have the width and depth as directed. The contractor shall do the necessary shoring and shuttering in required. The bottom of the excavated area shall be leveled both longitudinally and transversely as directed by removing and watering as required. No earth filling will be allowed for bringing it to level, if by mistake or any other reason excavation is made deeper or wider than that shown on the plan or as directed the extra depth or width shall be made up with concrete of the same proportion as specified for the foundation concrete at the cost of the contractor.

2.1 Disposal of Excavated Materials :

- 2.1.1 No materials excavated from the foundation trenches, of whatever kind they may be, are to be placed even temporarily up to 1.5 mts. or at the distance prescribed by the Engineer, from the outer edge of excavation. All materials excavated shall remain the property of the client. Materials suitable and useful for backfilling or other use shall be stacked in

convenient places but not in such a way as to obstruct free movement of men, animals and vehicles or encroach upon the area required for constructional purposes. The site shall be left clean of all debris on completion.

- 2.1.2 Disposal of excavated materials is subject to the following Unsuitable materials obtained from clearing site and excavation shall be disposed off within City Limit area as directed. Useful materials obtained from clearing site and excavation shall be stacked at convenient place as directed. Materials suitable for backfilling shall be stacked at convenient places as directed.

2.2 Carting Of Surplus Excavated Earth

- 2.2.1 The contractor has to convey the surplus excavated stuff from the site to the place as directed by Engineer-in-charge within the city limit, (maximum distance of 15 KM. from work site) should be dumped and/or spread in such a way as not to obstruct the path of vehicles but it should also make approach to lay the earth beyond that dump. Neither any excuse for difficulties for passing the vehicle over the dumped earth shall be allowed not any extra charge will be paid to the contractor for the same.
- 2.2.2 The conveying of earth shall be done in such a manner that it shall not cause any delay in the progress of the work.
- 2.2.3 During the conveying of the earth due care shall be taken that the earth should not be misused or wasted. The contractor shall have arranged to collect the mis-spread earth with his own cost
- 2.2.4 The earth should be loaded, unloaded and spread or dumped in the presence of the Engineer-in-charge or his representative.

3.0 Dewatering :

- 3.1 The contractor shall arrange bailing out of water in the foundation or trenches, accumulated due to rains or by springs, subsoil water, canal or river seepage and broken water mains or drains. The excavation shall be kept free from water and moisture content.
- (i) During inspection.
- (ii) When concrete work is in progress and till it comes above the natural water level.
- 3.2 Pumping from the interior of any foundation enclosure shall be done in such a manner as not to produce the possibility of the movement of water through any fresh concrete.
- 3.3 No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter unless it is done from a suitable sump separated from the concrete work by a water tight wall or similar other means or by any other method.
- 3.4 The operations of removal of water from trenches shall be so conducted by the contractor that there is no danger to foundation or stability of adjoining earth or structure.
- 3.5 In no case the dewatering should be stopped or failed during the work in progress.
- 3.6 The contractor has to arrange his own machinery, motor, engine, pump and other mechanical equipments with all the maintenance and labour as required for full efficiency of the work.

- 3.7 Necessary pumps, fuels and/or electrical power will be arranged by the contractor with all expenditure due to that on his part.

4.0 Plain Cement Concrete :

4.1.0 Materials:

- 4.1.1 Water shall conform to M-1, Cement shall conform to M-3. Sand shall conform to M-5 Stone aggregate 40-mm nominal size shall conform to M-9.

4.2.0 Workmanship:

4.2.1 General :

Before starting concreting the bed of foundation trenches shall be cleared of all loose materials, leveled, watered and rammed as directed.

4.2.2 Proportion of Mix:

The proportion of cement, sand coarse aggregate shall be 1 part of cement, 3 parts of sand 6 parts of stone aggregate measured by volume.

4.2.3 Mixing:

The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quantity of work if approved by Engineer-in-charge. When hand mixing is permitted by The Engineer-in-charge in case of break down of machinery and in the interest of the work, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However, in such case 10% more cement than otherwise required shall have to be used without any extra cost. The mixing in mechanical mixer shall be done for a period of 1 ½ to 2 minutes. The quantity of water shall be just sufficient to produce dense concrete of required workability for the purpose.

4.2.4 Transporting and placing the concrete:

The concrete shall be handled from the place of mixing to the final position in not more than 15 minutes by the method as directed and shall be placed into its final position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences. The concrete shall be laid in layers of 15 cms to 20 cms.

- 4.2.5 Compacting : The concrete shall be rammed with heavy iron rammer and rapidly to get the required compaction and to allow the interstices to be filled with mortar.

4.2.6 Curing:

After the final set, the concrete shall be kept continuously wet, if required by ponding for a period of not less than 7 days from the date of placement.

5.0 Reinforcement Cement Concrete :

- 5.1 The maximum size of coarse aggregate shall be as large as possible within the limits specified but in no case greater than one fourth of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and to fill the concrete in the form.
- 5.2 For reinforced concrete work, coarse aggregate having a nominal size of 20 mm are generally considered satisfactory.
- 5.3 For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of coarse aggregate should usually be restricted to 5 mm. main bars, or 5 mm. less than the minimum cover to the reinforcement whichever is smaller.
- 5.4 Where the reinforcement is widely spaced as in solid slabs, limitations of size of the aggregate may not be so important, and the nominal maximum size may sometimes be as great as or greater than the minimum cover.
- 5.5 Admixture may be used in concrete only with approval of Engineer-in-charge based upon the evidence that with the passage of time, neither the compressive strength of concrete is reduced nor are other requisite qualities of concrete and steel impaired by the use of such admixture.
- 5.6 Form work shall conform to the shape lines and dimensions as shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to safeguard against any settlement of the form work during the course of concreting and after concreting. The form work of shuttering, centering, scaffolding, bracing etc. shall be as per design.

Cleaning and Treatment of forms

All rubbish, particularly chippings shaving and saw dust shall be removed, from the interior of the form before the concrete is placed and the form work in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint.

Alternatively a coat of raw linseed oil or form oil of approved manufacturer may be applied in case of steel shuttering is used. Soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Care shall be taken that the coating does not get on construction joint surface and reinforcement bars.

Stripping Time

In normal circumstances and where ordinary cement is used forms may be struck after expiry of following period

- | | |
|--|----------|
| a] Sides of wall columns and vertical faces of beams | 2-4 Days |
| b] Beam soffits [props left under] | 7 Days |
| c] Removal of props slabs | |

i] Slabs spanning up to 4.5 Mts.	7 Days
ii] Spanning over 4.5 Mts.	14 Days
d] Removal of props to beams and arches	
i] Spanning up to 6 Mts.	14 Days
ii] Spanning over 6 Mts.	21 Days

Procedure when removing the form work

All form work shall be removed without such shock or vibration as would damage the reinforced concrete, before the soffit form work and struts are removed, the soffits and the concrete surface shall be where necessary in order to ascertain that the concrete has sufficiently hardened.

5.7 Centering

The centering shall be sufficiently strong to ensure absolute of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see that behavior of centering and form work is satisfactory during concreting. Erection should also be such that it would allow removal of forms in proper sequence without damaging either the concrete or the form to be removed.

5.8 Scaffolding

All scaffolding, hoisting arrangements and ladders etc. required for the facilitating of concreting shall be provided and removed on completion of the work by the contractor. The scaffolding, hoisting arrangements and ladders etc. shall be strong enough to with stand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge.

However, the contractor shall be wholly responsible for the safety to the scaffolding, hoisting arrangements, ladders, work and workman etc.

The scaffolding, hoisting arrangements and ladders shall allow easy approach to the work spot and afford easy inspection.

5.9 Re-use

Before re-use, all forms shall be inspected by the Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints gone over, repaired where required. Inside surface shall be retreated to prevent adhesion of concrete.

Reinforcement

The bars shall be kept in position by the following methods-

- [i] In case of beam and slab construction, sufficient number of precast cover blocks in cement mortar 1:2 (1 Cement, 2 coarse sand) about 4 x 4 cms. section and of thickness equal to the specified cover shall be placed between the bars and shuttering as to secure and maintain the requisite cover of concrete over the reinforcement.
- [ii] In case of columns and walls, the vertical bars shall be kept in position by means of timber temphes with slots accurately cut in them, the temphes shall be removed after concreting has been done below it. The bars may also be suitably tied by means of annealed steel wires to the shuttering to maintain their position during concreting.
All bars projecting from pillars, columns beams slabs etc. to which other bars and concrete are to be attached or bounded to later on, shall be protected with a coat of thin neat cement grout, if the bars are not likely to be incorporated with succeeding mass of

concrete within the following days. This coat of thin neat cement shall be removed before concreting.

5.10 Mixing

For all works, concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction.

Measured quantity of aggregate, sand and cement required for each batch shall be poured into the drum of the mechanical mixer while it is continuously running. After about half a minute of dry mixing measured quantity of water required for each batch of concrete mix shall be added gradually and mixing continued for another one and a half minute. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons, it shall be done on a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign materials gets mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Specified quantity of water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10% above that specified.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Engineer-in-charge the first batch of concrete from the mixture shall contain only two thirds of normal quantity. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

5.11 Consistency

The degree of consistency which shall depend upon the nature of the work and methods of vibration of concrete, shall be determined by regular slump tests in accordance with I.S. 1199- 1959. The slump of 10 mm to 25 mm shall be adopted when vibrators are used and 80 mm when vibrators are not used.

5.12 Inspection

Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength, alignment and general fitness but such inspection shall not relieve the contractor of his responsibility for the safety of men, machinery, materials and for results obtained. Immediately before concreting, all forms shall be thoroughly cleaned. Centering design and its erection shall be got approved from the Engineer-in-charge. One carpenter with helper shall invariably be kept present throughout the period of concreting. Movement of labor and other persons shall be totally prohibited from reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel

reinforcement in position is not disturbed. For ensuring proper cover mortar blocks of suitable size shall be cast and tied to the reinforcement timber, kapachi or metal pieces shall not be used for this purpose.

5.13 Transporting and Laying

The method of transporting and placing concrete shall be as approved. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes place.

All form work shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

Concreting shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes of its discharge from the mixer. Except where otherwise agreed to by the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 meters when internal vibrators are used and not exceeding 0.30 meters in all other cases.

Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into placed from a height exceeding 2 meters. When trunking or chutes are used they shall be kept close and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened swept cleaned, thoroughly wetted, and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all fresh water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old work, particular attention being given to corners and close spots.

All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators cannot be used.

Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of breakdowns. Concrete shall be judged to be compacted when the mortar fills the spaces between coarse aggregate and begins to cream up to form an even surface. Compaction shall be completed before the initial setting starts i. e. within 30 minutes of addition of water to dry mixture. During compaction, it shall be observed that needle vibrators are not applied on reinforcement which is likely to destroy the bond between concrete and reinforcement.

5.14 Compacting

Concrete shall be properly compacted by use of vibrators or by Roding and spacing as directed by the Engineer, tamping as above shall be continued until all the entrained air is removed and the concrete has been compacted and completely fills the form. The sides of the form work shall be gently tapped by spades during concreting.

Concrete shall be compacted during placing, with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point that segregation results.

(i) Types of vibrators

Vibrators shall conform to IS specification. Types of vibrator to be used shall depend on structure where concrete is to be placed. Shutter vibrators to be effected, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators shall have” no load” frequency, amplitude and acceleration as per IS 2505 depending on the size of the vibrator. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

(ii) Use of Vibrators

The exact number of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall Immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibrations at the top of a lift e.g. in a column or wall.

(iii) Melding Successive Batches

When placing concrete layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the succeeding layers.

(iv) Penetration Vibrator

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

(v) Vibrating against Reinforcement

Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

(vi) Use of Form Attached Vibrators

Form Attached Vibrators shall be used only with specific authorization of engineer in charge

(vii) Use of Surface Vibrators

The Use of Surface Vibrators will not be permitted under normal conditions. However, for thin slabs such as highways, runways and similar constructions, surface vibration by specially designed vibrators may be permitted upon approval engineer in charge.

(viii) Stone Pockets and Mortar Pondages

The formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur they should be dug out, reformed and refilled to sufficient depth and shape for thorough bonding as directed by engineer in charge.

5.14.1 Placement Interval

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete and before the start of a subsequent placement.

5.14.2 Special Provision in Placing

When placing concrete in walls with openings, in floors of integral slab and beam constructions and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be. Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by the engineer in charge.

5.14.3 Placing Concrete through Reinforcing Steel

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position.

5.14.4 Bleeding

Bleeding or free water on top of concrete being deposited into the forms shall be cause to stop the concrete pour and the conditions causing this effect corrected before any further concreting is resumed.

5.15 Curing Of Concrete

All concrete work shall be protected from direct rays of the sun and be kept wet for a minimum period of 10 days or for longer directed by Engineer-in-charge. Concrete laid shall not be disturbed and shall be suitably protected from any injury until completely set, particular care shall be taken at all corners and edges of the member. All horizontal concrete surface shall be kept constantly wet by ponding or any other manner. Concrete surface shall be cured either by sprinkling or by spraying water.

Flat or fine vertical surfaces may be covered with damp gunny bags and watered frequently. In order to ensure adequate quantities of water for curing, the contractor shall make necessary arrangement such as providing sufficient lengths of temporary pipe line of suitable sizes, storage of water in tanks and/or use of bhisties.

5.16 Concreting Through Water :

Concrete shall not be deposited under water without the prior consent in writing of the Engineer. In the event of permission being given, the amount of cement in every batch shall be increased by twenty five percent entirely at the expense of the contractor and he shall take every reasonable precaution to ensure that cement or fine aggregate is not washed out of any concrete so deposited by any flow of water.

5.17 Finish Of Concrete :

- [a] On removal of the shuttering and after the approval of the Engineer, honey combed surfaces shall be made good immediately by the method approved by the Engineer and superficial water and air holes shall be filled in. Unless instructed to the contrary, the faces

of exposed concrete placed against shuttering shall be rubbed down with a carborandum stone immediately upon removal of the shuttering to remove fins or other irregularities. The face of concrete for which shuttering is not provided, other than a slab, shall be smoothed with a wooden float to give finish equal to that of the rubbed down face where shuttering is provided. No cement wash, mortar or print may be applied to any concrete surface without the express instruction or permission of the Engineer.

- [b] All floors, slabs and inverts shall be laid to the required depths, thickness inclinations and curvatures, shown on the detail drawings. Subsequently, and just before settling the concrete shall be finish off to a smooth and even surface with metal floats, unless otherwise ordered.
- [c] Laying of concrete floors and inverts in two courses will not be permitted, except where specified or special permission of the Engineer in writing. Where screeds are required or approved, the structural concrete shall be keyed and prepared as specified for construction joints and the screeding properly bonded.
- [d] First class plane surface free from ripples, hollows air holes or exposed aggregate is required.

5.18 Sampling & Testing Of Concrete

Samples from fresh concrete shall be taken as per I.S. 1199-1959 and cubes shall be made, cured and tested at 7 days or 28 days as per requirements in accordance with I.S. 516-1959. A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested i.e. the sampling should be spread over the entire period of concreting and cover all mixing units. The minimum frequency of sampling of concrete of each grade shall be in accordance with the following---

Quantity of Concrete in the work	No. of Samples
upto 50 Cmt.	2 sets*
51 & above	3sets + 1 additional sample for each additional 50 Cmt or part thereof

*- set means 3 nos. of cubes.

Note : At least one sample shall be taken from each shift. Ten test specimens shall be made from each sample, five for testing at 7 days and the remaining five at 28 days. the samples of concrete shall be taken on each day of the concreting as per above frequency. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveals a poor quality of concrete and in other special cases.

The average strength concrete in proportion 1:4:8; 1:3:6; 1:2:4 & 1:1.5:3; 1:1:2 of the group of cubes cater for strength of 75, 100, 150, 200 & 250 Kg/Sq.cm. respectively at 28 days. 20% of the cubes cast for each day may have value less than the specified strength provided the lowest value is not less than 85% of the specified strength. If the concrete made in accordance with the proportions given for a particular grade does not yield the specified strength, such concrete shall be classified as belonging to the appropriate lower grade. Concrete made in accordance with the proportions given for a particular grade shall not, however, be placed in a higher grade on the ground that the test strength are higher than the minimum specified.

5.19 Stripping

The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike the form work. While fixing the time for removal of form work, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. In normal circumstances (generally where temperatures are above 20 degrees centigrade) and where ordinary concrete is used, forms may be struck after expiry of periods specified for respective item of form work.

All form work shall be removed without causing any shock or vibration as would damage the concrete. Before the soffit and struts are removed the concrete surface shall be exposed, where necessary in order to ascertain that the concrete has sufficiently hardened, centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal parts shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to re-use the form work, it shall be cleaned and made good to the satisfaction of the Engineer-in-charge. After removal of form work and shuttering, the Engineer-in-charge shall inspect the work and satisfy by random checks that concrete produced is of good quality.

Immediately after the removal of forms, all exposed bolts etc. passing through the cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm. below the surface of the concrete and the resulting holes be filled by cement mortar. All fine caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in proportions used in the grade of concrete that is being finished and of as dry consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which are pointed shall be kept moist for a period of 24 hours.

If rock pockets/honeycombs in the opinion of the Engineer-in-charge are of such an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and required the removal and replacement of the portions of the structure affected.

5.20 Expansion And Construction Joints :-

5.20.1 General:

The item of providing expansion joints and construction joints in concrete includes all the material, labour, tools and plants necessary for completing the work in best workmanlike manner .

5.20.2 Materials:

The materials to be used in the joints shall be ribbed PVC water stop of specified width approved by the engineer, bitumen impregnated fibre board as filler conforming to IS:10566

Tender for Up-gradation of 10 MLD out of existing
18.5 MLD CETP

and approved sealant material(In case of movement joint only).In addition,IS:12220-1987 and 1838 shall also be adhered.

5.20.3 Joints In Floor:

Joints in floor shall be provided as specified on drawings or as directed by engineer in charge. In case of PVC water stops to be provided horizontal positions flat-footed PVC water stop shall be used. The water stop shall be provided in such a way that half the portion of water stop (width wise) is embedded in the concrete and half remains exposed for next concrete. Steel reinforcement shall not be discontinued where construction joints in floor are provided.

5.20.4 Joints In Wall

5.20.4.1 Expansion Joints

Expansion joints shall be provided in the walls at positions shown on drawings or as directed by the Engineer In-Charge. Water stops shall be kept in position with the help of bitumen impregnated fiber board fillers. Concrete shall be laid in such a way that half the portion of water stops remains exposed for next concreting. Steel reinforcement shall be discontinued as shown on the drawings or as directed by the Engineer In-Charge.

Expansion joint consists of a fiber board impregnated with bituminous material to render it durable and waterproof. It is compressible, resilient and non-extrudible. It shall conform to IS:1838-P(1)/1983 with latest amendment.

(a) Purpose :

To permit free movement of the concrete slabs during expansion and contraction. To provide a water proof seal. To resist entry of foreign matter into the joint space.

(b) Physical Characteristics :

Consists of a fiber board impregnated with bituminous materials.

Compressible. Possesses a high degree of recovery once compression is relaxed. Available in thicknesses of 12 mm, 18 mm and 25 mm (1/2", 3/4" and 1" respectively).

(c) Sealing Compound :

IS :1834-1984, Grade A (Physical Characteristic/Purpose)

Dispuurs good adhesion towards concrete.

Has the ability to withstand extension without cracking.

Low susceptibility to flow during hot weather conditions.

Is durable and plastic.

Offers resistance to ingress of foreign substance.

Durable, compressible and non-extruding materials.

Horizontal joints shall, where used in water-retaining structures be sealed with a cold pouring

poly sulphide rubber sealing compound of quality equal to, or better than serviced “Paraseal”. Horizontal joints in roofs, floors and other non-water retaining structures shall be sealed with an approved sealant with properties equal to or better than serviced “Paraplastic 41”. Vertical joints and joints in the soffits of slab in both water retaining as well as non-water retaining structures shall be sealed with a trowel or gun applied poly sulphide rubber sealing compound such as serviced :Vertiseal” or equivalent. Sealing compounds shall be fully cured before water is permitted to come in contact. At 40°C ,the curing time would be approximately 7 weeks for poly sulphide compound.

(d) Application Methodology :

Before applying SHALITEX SEALING COMPOUND, the sces of the joints should be cleaned of dust etc. by a jet of dry air, followed by through drying.

The sides should be sprayed or brushed with PRIMER of approved make as per the instruction of Engineer-in-charge.

Requirements : Primer should be based on a consumption of 78 running meters per liter, for 25 mm depth of joint.

Once the primer has dried completely, SEALING COMPOUND is poured into the joint. The working temperature is 170°C-185°C (345°-365°F). SEALING COMPOUND should be cut into small pieces before adding to the heater, whose bottom should always remain covered with the molten sealing compound when firing is in progress.

During the pouring process, spillage can be minimized if wooden boards are laid on each side of the joint. The pouring should be done from can with extended spouts.

The quantity of SEALING COMPOUND requires per 100 meters of running joint of 25 mm depth, with the following thickness:

9.5 mm thickness	-	29.5 Kg.
12.0 mm thickness	-	40.2 Kg.
18.0 mm thickness	-	59.0 Kg.
25.00 mm thickness	-	82.0 Kg.

(An allowance of 5% should be made for wastage during application.)

5.20.4.2 Construction Joints

Construction joints shall be provided between two lifts of concrete as shown on drawings or as directed by the engineer in charge.

A groove shall be formed around exposed portion the PVC water stop for proper jointing. Care shall be taken during concreting to keep the water stop in vertical position. In no case shall the water stop be punctured on nailed with the binding wire to keep it in position. Wherever required to be jointed the water stop shall be welded in T,X or L pattern as per the instruction of the Engineer.

A construction joints is defined as a joint in the concrete introduced for convenience in construction at which special measures are taken to achieve subsequent continuity without provision for further relative movement.

No concrete shall be started until the Engineer-in-Charge has approved the method of placing the positions and form of the construction joints and lifts. The construction joints shall be so located as not to impair the strength of the structure.

Concrete placed to form the face of a construction joint shall have all Laitance removed and the aggregate exposed prior to the placing of fresh concrete. The laitance shall wherever practicable be removed by spraying the concrete where it is still green. The whole of the concrete surface forming part of the joint shall be hacked to expose the aggregate. Where aggregate is damaged during hacking, it shall be removed from the concrete face by further hacking. All loose matter shall be removed and the exposed surface thoroughly cleaned by wire brushing, air blasting or washing, leaving the surface clean and damp. Immediately before fresh concrete is placed, a 12 mm thick layer of sand/cement mortar mixed in the same proportions as in the concrete shall be spread in the horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal pours to avoid Laitance. The new concrete shall be well worked against the prepared face before the mortar sets. Special care shall be taken to obtain thorough compaction and avoid segregation of the concrete along the joint plane.

5.20.4.3 Complete Construction Joints

These joints are provided in the top layer of the floor of the reservoir with a view to localize shrinkage cracks at these joints. These joints are characterized by complete discontinuity of steel without any initial gap as in the case of expansion joints. The joints between the adjacent panels of the floor shall be provided with a groove at top of dimension 12 mm x 12mm and shall be filled with poly sulphate sealant and they shall be provided with water stops as specified earlier.

The joints between top layer of the floor and the walls or between the top layer of the floor and the column footing, shall also be provided with a groove of 12mm x 12 mm which shall be filled with sealant material as per specification given below:

Joints Fillers: Joint fillers shall be durable, compressible and non-extruding material, It shall be non-staining, non-absorbent and compatible with sealant material used.

Sealant material: The joint sealing compounds should be capable of properly ensuring water tightness in vertical, horizontal and inclined joints in water retaining and other structures having severe service conditions in respect of anticipated movement or exposure to weather. Typical uses include expansion joints in the walls of water tank, and in roof and deck slabs exposed to the weather.

The compound should be flexible, durable and weather proof and should have sufficient elasticity to allow joints movements of the concrete components wherever necessary.

The sealant shall be poly sulphide rubber sealing compound conforming to BS 4254 of 1967 or ASA-A 116-1-1960 or any other equivalent specifications. It shall be capable of cold

pour application for horizontal joints and cold application of vertical and inclined joints. The sealing compound shall be suitable for the use in the tropics where it will be subjected to high ambient temperatures, humidity and very strong sunlight. It shall not degrade under these conditions and shall be suitable for use with raw and treated water including water dosed with chlorine. The sealant shall be odor and taint free from lead. It shall be available in choice of colors and shall give a thorough, permanent seal, be waterproof, non-staining and remain resilient. Sealing compound for vertical and horizontal joints shall be used complete with the appropriate quantity of primer as per manufacturer's instructions for use. The primers should ensure good adhesion to the concrete and should be specially developed for respective sealing compound. The sealants shall be applied with pressure guns or without guns as specified by the manufacturers. Sealing compound shall be fully cured before water is permitted to come in contact.

The sealant material should be formulated as to have a storage period of one year at a temperature of 40° C.

5.205 Movement Joints

Movement Joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instruction of manufacturers of proprietary jointing materials and shall, if required by the Engineer-in-Charge, demonstrate that the joining materials can be applied satisfactorily.

The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved performed joint filler.

Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face of the caulking strip and a width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound

5.20.6 Water Stops and Joints Fillers

(a) Water stops

At all construction, contraction and expansion joints in the water retaining structure and wherever specified or directed by the Engineer in-Charge, water stops shall be provided. The water stops shall be PVC type or of any other equivalent material as approved by the Engineer-in-Charge. PVC water stops shall have a tensile strength of not less than 14

MN/m² and elongation at break of not less than 300%. Water stops shall not be exposed to direct sunlight for long period. Before being concreted in water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent section of the panels for equal width.

As far as possible, jointing on site shall be confined to the making of butt joints in straight runs of water stops and all the joints should be monolithic. Where it is agreed with the Engineer-in-Charge that it is necessary to make an intersection or change of direction of any joint, other than a butt joint in a straight run on site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer-in-Charge may require.

Flexible water stops shall be fully supported in the formwork, free of nail and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.

The different types of water stops to be used in liquid retaining structures will be as follow as:

Types of Water Stops:

Sr. no	Types of Joints	Types of water stops
1	Partial/complete contraction joint in walls and slabs	230 mm wide, ribbed with hollow centre bulb & 10 mm minimum thickness
2	Expansion joints in walls and slabs	230 mm wide, ribbed with hollow centre bulb & 10 mm minimum thickness
3	Construction joints in raft	230 mm wide, ribbed with hollow centre bulb & 10 mm minimum thickness
4	Construction joints in wall	230 mm wide, ribbed with hollow centre bulb & 10 mm minimum thickness
5	Expansion joints in raft	230 mm wide, ribbed with hollow centre bulb & 10 mm minimum thickness

The water stopper shall be 10mm thick either “sinecos/arti” and equivalent PVC Water Stoppers or any other make as approved by the Engineer-In-Charge

Concreting shall be carried out continuously up to construction joints, or Predetermined by the Engineer-in-charge.

When the work has to be resumed on a surface which has hardened, such surface shall be roughened. The surfaces shall then be thoroughly cleaned, and all laitance removed with wire brushes and compressed air. In addition to that, the surface shall be completely wetted and slashed with a coat of neat cement grout immediately before placing of new concrete. The first layer of concrete to be placed on these surfaces shall not exceed 150 mm in thickness and shall be well rammed against old work, particular attention being paid to corners and close spots. Shear keys shall be provided to all construction joints.

Reinforcing rods shall be extended 35 diameters beyond construction joints unless otherwise indicated.

Joints in beams shall be kept at places where the shear force is minimum and these shall be at right angles to the direction of main reinforcement. In the case of columns, the joints shall be horizontal and about 150 mm below the bottom of the deepest beam framing into the column head, and the portion of the column between the stopping off level and the top of the slab shall be concreted with the beam. Joints in the R.C.C. slab shall be provided parallel to main reinforcements, or slabs supported thereon. Beams, girders, brackets, columns capitals and branches shall be considered as part of the floor system and shall be monolithically placed therewith.

Construction joints in water retaining structure :

Construction joints for the water retaining structures and underground storage area and lift pits in water logged areas shall be constructed as directed by the Engineer-in-charge prior to taking up any work of this type. Work shall conform to I.S. 3370 unless shown otherwise.

Standard key joints should, however, be provided if so directed, in addition to the water stoppers in the concrete.

The water stoppers shall be PVC or rubber type. Whenever required the transverse joints of the sheets shall either be welded or brazed, or overlapped. In case of overlapping of the stoppers the overlap should be minimum and equal to the width of stoppers, the stoppers can be of approved make. Deposition and compaction of concrete prior and after the construction joint should be very carefully done, so as to avoid internal honey combing. Before the next pour of concrete, the joints should be cleaned of the loose mortar, aggregates dust, preferably by hosing down the water. The surface of the old concrete which is coming in contact with the next pour should be wire brushed and reasonably sprinkled with thick cement slurry so as to ensure proper bond.

5.21 Protection Of Concrete :

- a] Concrete placed below ground level shall be protected from falling earth during and after placing. Concrete placed in ground containing deleterious substances shall be kept free from contact with such ground and with water draining there during placing for a period of three days or as otherwise instructed thereafter.
- b] No load of any kind, however light, shall be allowed on concrete which has not properly set, and unless it has been pronounced by the Engineer.
- c] Immediately after the compaction of the concrete has been completed contractor shall ensure that it is adequately protected from the weather. Protective materials shall be kept continuously damp and in position for a minimum period of fourteen days or such other times as the Engineer may direct.
- d] Where large sections of concrete are poured special precautions as approved by the Engineer shall be taken to reduce and dissipate the heat generated by the settling and hardening of the concrete.

5.22 Concrete Additive :

- a] The use of retarders will not be permitted.

- b] Other additives shall only be used if written permission has been obtained from the Engineer. They shall be obtained from a manufacturer approved by the Engineer and shall be used strictly in accordance with the manufacturer's and the Engineer's instruction.

5.23 Permission For Starting The Concrete Work :

The surface whether concrete or rock or form work etc. on which concrete is to be placed, shall be got inspected and approved by the Engineer, who shall then issue the permission for starting the work. Any concrete work done without such a permission shall be cut and removed at the cost of contractors. If concreting is to be done on concrete previously laid, the surface of the old concrete shall be cleaned with wire brushes and all laitance removed to expose the original surface of metal and sand particles, etc. It shall then be covered with a 7 mm thick layer of cement mortar [1:2] before laying the fresh concrete.

B] Form Work :

1] Material :

All form work for concrete works shall be made either of planked and matched timber or M.S. plates. The timber for the form work shall be hard wood dry and well seasoned. It shall not be so dry to absorb water from concrete nor shall it be so green as to shrink after erection. When steel plate are used for forms, the plates shall be free from wrinkles, dents, lumps or other imperfections. The timber boards or steel plates shall have sufficient thickness to withstand the construction loads and the pressure exerted by the wet concrete as well as vibration during placing of concrete.

Normally the thickness shall not be less than 38 mm for timber and 18 gauge for M.S. plates. However, in case where the depth of concrete to be poured in the form work is small, the thickness of timber planks may be reduced in consultation with the Engineer.

2] Arrangements :

All the forms shall conform to the shape, lines dimensions as shown on the drawings. The form work shall include all wedging, bracing, tie rod, clamps, stop off boards and other devices necessary to mould the concrete to the desired shape. The form work shall be so constructed as to remain sufficiently rigid during the placing and compacting of concrete.

The use of bolts passing through concrete members which form parts or any water retaining structures shall be permitted for the purpose of securing and aligning the form work. The form work shall be so arranged as to permit easy erection initially and later easy removal without disturbing the concrete.

Before concrete is placed all rubbish shall be removed from the interior of the forms and the surfaces of the work in contact with concrete shall be cleaned and thoroughly wetted, and inside surface treated with lime, oil or any other material. The slab centering shall be covered with double wax' water proofing paper' or tar paper or polythene sheet as directed by the Engineer.

3] Removal of form work :

In no circumstances shall forms be struck off until the concrete reaches adequate strength as required, without obtaining permission of the Engineer. All the form work shall be removed without such shock or vibration as would damage the concrete. Removal of the form work whether whole or in part, shall rest entirely with the contractor who must never the less be guided by the opinion of the Engineer in this regard.

4] Surface treatment and finish :

When the form work is struck, all the faces of concrete shall be smooth and sound, free from voids and air holes, If any roughness filled up while the concrete is still green, with cement wash and/or 1:1/2 cement mortar properly troweled and finished as directed by Engineer. If the concrete shall be dismantled and fresh concrete of proper quality be reinstated at contractor's cost.

5.24 Concrete In Water Retaining Structures :

General

- a] The specifications define the materials, constructional and performance requirements for water tight concrete necessary for following structures.

The work shall be done in accordance with this specification together with IS:3370 [PART-I to IV].

- b] The water retaining structure is to be constructed as per the general design indicated in the drawings supplied/However, necessary for piping and electric conduits are to be provided during construction without any extra cost to owner.
- c] After construction, the structure has to be tested for water tightness as detailed hereunder and as per relevant Indian Standard Specifications, which is also included in the scope of this contract.
- d] For such structures where water tightness in addition to structural strength is of prime importance, special care shall be taken to get the most suitable grading of aggregate so as to produce the densest possible concrete.

Water cement ratio shall also be controlled, consistent with the requirement of workability, to produce an impervious concrete.

- e] Concrete shall have at least the minimum cement required as per IS:3370.
- f] The concrete between the reinforcement and the form work on the water face shall be well compacted and the board joints made tight so that seepage of water shall not take place.

Shutter vibrators at a rate of one vibrator per 2.5 m² of shutter area shall be used to produce a compact concrete with dense skin. wherever it is not possible to use shutter vibrators, pin vibrator shall be used. No extra payment will be made for use of shutter vibrators. The form work must also be so designed that shutter vibrators can be fixed and dismantled quickly.

5.25 Admixture :

Admixture shall be used in concrete only with the approval of the Engineer-in-charge. Normally approved compounds like "CICO", "PIDIPROOF" or equivalent of proven quality shall be permitted.

It shall be used as per manufacturers specifications and the direction of the Engineer-in-charge. Contractor shall provide test certificates from recognized laboratories before use of admixture, if so desired by the Engineer-in-charge. Calcium chlorides shall not be used in admixture.

Construction, contraction and Expansion joints :

Joints are potential positions of leakage. It is also advantageous to avoid horizontal joints by using continuously moving forms or by providing sufficient form work of ordinary type to enable the entire wall to be concrete without interruption. Where days' work joints are formed whether horizontally or vertically, they shall be rebated as called out on drawings. Care shall be taken to remove from the earlier lift all loose pieces of gravel/stone chips, wooden, country nails or any other foreign materials. All laitance

shall also be thoroughly removed. If necessary the face of the old concrete shall be well hacked to expose the aggregate and after washing the surface, a thin coat of mortar or grout [1 Cement: 1 Sand] shall be applied immediately before resuming concreting. A water stop shall be placed through the joint specifically where the tank walls bond into the floor. Where an effective bond cannot be assumed at horizontal joints, a method that has been successful is to form a socket and spigot joint well caulked with asphalt or a bitumen filler and arrange to ensure that the water pressure tends to force the filling into rather than out of the joint. joints shall not be made at changes of concrete section if they can be conveniently placed elsewhere. Moving them even a few cms is often sufficient to prevent the secondary stresses being concentrated in one place leading to cracks. In long reservoir walls the design often incorporates permanent joints which assist in preventing cracks due to shrinkage and temperature changes. When these joints are not indicated in drawings, it is best to concrete the wall in short section and provide spaces as per drawings between sections. As far as possible after completing the sections, the intervening spaces shall be filled in taking care to bond the old with the new work.

5.26 Rendering :

Rendering of cement mortar with addition of water proofing compound or equivalent shall be used with the object of covering weak patch in the concrete which still fresh the form work being struck as early as possible and the rendering applied immediately. The concrete surface shall be well wetted and if necessary, hacked or otherwise treated to form a key. If the rendering is applied in two coats, the joints shall be broken. The mortar shall be steel troweled, but finished with a wooden flat.

5.27 Hydraulic Testing :

Testing shall be restricted to underground, on ground and overhead structure only. These structures shall be tested strictly in accordance with IS : 3370 [PART-I] for water tightness. for underground structure the total maximum drop in water surface level over seven days shall not exceed 40 mm.

5.28 Treatment Of Suspension Of Work :

Whenever work is suspended on any section for more than one hour, the horizontal edges of the concrete next to the forms on surface which will be exposed shall be brought to a horizontal plane perpendicular to the plane of the forms and treated so that the finished work will shown smooth straight line.

5.29 Fittings :

Pipes or other fittings passing through the walls and bottoms of water retaining structures are another potential source of weakness, and shall be on site in time to erect them in position in the shuttering before concreting commences. They shall be well embedded in the concrete and if provided with normal water bar flanges, there is little risk or leakage. An objection to building in fittings is that of the flanges are not in line with connecting flanges extra labour is required in making adjustments. Some Engineers prefer to have holes and fix the pipes fittings subsequently after completing the concrete work, however it is difficult to ensure that this construction shall definitely be leak proof.

Fittings built into concrete shall preferably be of non- corrosive material, so as to avoid frequent replacement leading to water leakage. If made of ferrous metals, the sections should be sufficiently substantial to prevent weakening by small corrosions. Care shall be taken that corrosive metal coming in contact with Portland cement shall receive a bitumen or equivalent corrosion preventing paint.

5.30 Grouting :

i] Grouting of Pockets -

The grouting shall be done with C.M. in proportion of one part of Portland cement plus one part of sand and one part of grit (mix. size 6 mm). Adequate quantity of water shall be added. The pockets shall be thoroughly cleaned before fixing the holding-down bolts. In cases where the anchor bolts with sleeves are used, it should be the responsibility of the contractor to keep them clean. Similarly, the treated portion of the bolts shall be greased to protect them from damage. Grout shall be gradually poured in the pockets without disturbing the holding down bolts, and shall be tamped with a steel rod for proper compaction.

[ii] Grouting under base plates & machine bases -

The grouting shall be done in C.M. of one part of Portland cement and 2 parts of sand mixed with adequate quantity of water, unless otherwise specified. It shall be worked in and compacted, so that the entire space under base plates and around the anchor bolts are thoroughly filled with the dense grout. Care should be taken that no air bubbles are left inside the grout. The grout shall be cured for a minimum period of 7 days by wetting the exposed areas. The shin plates under the bases should be left undisturbed while grouting in undertaken, prior to grouting, the space under the steel shall be thoroughly cleaned and watered without disturbing the shin plates. No grouting work shall be carried out before all the bases are properly aligned and plumbed. After the grouting is done, anchor bolts should be tightened, while the grout is green till all the air bubbles cease and cement slurry comes out to ensure that the surface of bearing plate is entirely in contact with the grout.

5.31 Reinforced Cement Concrete [R.C.C.] :

Mix Design [M-30]

The Contractor shall get the concrete mix designed confirming to various design parameters given in these specifications and latest revision of IS:10262 for each grade of concrete mentioned above by a Government approved laboratory. The cost/ charge of the MIX DESIGN work shall be borne by the Contractor.

The MIX DESIGN shall be got approved from the Consultant. No volume batching shall be allowed at site. The concrete mix shall be either RMC or optionally at site it shall be with **Digital Mixer Machine**. The proportion of cement, sand and coarse aggregates, water and admixtures if any shall be determined by weight. The Contractor shall make arrangements to weigh water by an electronic device at the site.

The Contractor shall follow the following specifications for mix design reinforced cement concrete work.

5.31.1 Proportioning Mix:

The mix of fine and coarse aggregate, cement and water as per the DESIGN MIX shall give the most dense concrete confirming to minimum quantity of cement paste and maximum water cement ratio for binding the materials to give required strength, Water content and the water cement ratio shall give the specified strength with the materials proposed for use in actual work carried out before the work is started, adopting the consistency suitable for the work and method of compaction that will be actually used on site subject to the water cement Ratio as Tabulated separately.

5.31.2 Test:

Tests shall confirm to the specifications laid down in I.S. 456 – 2000. These tests shall be got done in an approved laboratory at the cost of Contractor.

a) Preliminary tests :

In preliminary test, three separate tests shall be carried out on samples collected from different stacks. Each test shall be carried out with six samples of 15 cm. (About 6”) cubes and 3 of these shall be tested at 7 days and 3 at 28 days. In preliminary tests the average crushing strength attained shall be 33 percent higher than that required on work tests.

b) Work test:

For each of the work test, 6 samples shall be prepared from the concrete being used on the site, 3 samples being tested at 7 days and the remaining 3 samples at 28 days. Work tests shall be carried out on each of the first six days and subsequently once in three working days or for every 60 cu.m. of concrete which ever is less and also whenever the quality or grading of the materials is changed. When a relation between the strengths at 7 days and 28 days is established, only 3 samples may be prepared and tested at 7 days only. This number of controlled specimen tests may be increased if the Engineer-in-charge considers it necessary.

5.31.3 Field Mix :

In the work tests, bulkage of sand due to moisture, if any, should be allowed for different batches according to the moisture actually present at the time of mixing. The moisture will be taken into account in controlling the mixing water also. The proportions once fixed by preliminary tests shall not be changed so long as the materials are the same, subject only to the quantities of fine aggregate and water being adjusted to compensate for bulkage due to the moisture in sand and free water in fine aggregate at the time of use.

No change of materials shall be allowed unless fresh tests with new materials show satisfactory results.

Water and cement content per batch or concrete as determined MIX DESIGN shall be maintained constant except for suitable allowances to be made for surface moisture of the aggregates at the time of actual use. Immediately upon the receipt of the award of the contract, the Contractor shall inform the Engineer-in-charge the exact location of the sources of the acceptable materials which he proposes to use and get approved materials to be used. The CONCRETE MIX shall be got designed in an approved laboratory by the Contractor with minimum water cement ratio to give specified strength in the preliminary tests and the proportions got approved by the Engineer-in-charge in writing. These proportions shall be used so long as the materials contains to be of the same quality and from the same source subject only to slight changes in the relative quantities of fine and coarse aggregates for the purpose of promoting workability provided the works tests require the same. If during the progress of the work, the Contractor wishes to change the materials, the proportion shall be fixed on the basis of fresh MIX DESIGN to give the required strength after the Engineer-in-charge is satisfied that the materials satisfy the specifications. No adjustment of cost shall be made for change of proportions of cement fixed in the original preliminary tests.

5.31.4 Maximum Water Cement Ratio :

Types of concrete	Mix	Maximum water	
		Strength	cement ratio
Reinforced concrete	(a) M -350		0.40
	(a) M-300		0.45
	(b) M-250		0.50
	(c) M-200		0.55
	(d) M-150		0.60

5.31.5 Detailed Specifications For Concrete:

[1] Ingredients

1. Cement :

The cement shall be ordinary Portland Cement confirming to IS:269 or Sulphur Resistance cement as specified. Under special circumstances other cements may be used with prior approval of Engineer-in-charge.

2. Aggregate:

Aggregates shall comply with the requirements of IS:383. Generally aggregates having a nominal size of 20 mm shall be used. Coarse and Fine aggregate shall be weigh batched separately. Sand shall conform to M-5, Grit shall conform to M-6, Graded stone aggregate of design size shall as per IS

3. Water :

Water used for mixing and curing shall be as per Clause 5.4 of IS:456-2000.

4. Admixtures:

Admixtures such as plasticizer / super plasticizer shall be used with prior approval of the Engineer-in-charge.

[2] Grades of concrete to be used shall be M10, M15, M20, M25, M30.M35

Minimum cement content for different grades of concrete shall be as follows :

<u>Grade</u>	<u>Minimum cement content in kg.</u>
M-100	230
M-150	290
M-200	360
M-250	380
M-300	410
M-350	425

- [3] All reinforcement shall be free from loose mill scale, loose rust, and coats of paints, oil, mud or other coatings. The Contractor shall get the reinforcement cleaned by using wire brush, rubbing with gunny bags, light acid itching etc. as required.
- [4] Workability of concrete shall be as per Clause 6.0 of IS:456.
- [5] Durability :

In order to provide / produce durable concrete with low permeability, it must have an adequate cement content and a low water cement ratio. By using strong dense, aggregates, sufficient low water cement ratio, ensuring thorough compaction and sufficient hydration of cement through proper curing methods, a sufficient low permeability is achieved. Therefore cement content shall be sufficient to provide adequate workability with a low water cement ratio so that concrete can be completely compacted with the means available.

The permissible limits of chlorides and sulphate in concrete shall be as per Table 1 of IS-456-2000.

5.31.6 Concrete Mix Proportioning

The Concrete mix should be so proportioned that when the concrete is hardened it shall be of the required strength, durability and surface finish. For this purpose the Contractor shall establish a well equipped concrete testing laboratory at site. The results of these shall be sent to Consultant for their comments / approval / suggestion for modification of Design Mix.

- [1] Strength Requirement of Concrete :

Where ordinary Portland cement conforming to IS:269 or Portland blast furnace cement conforming to IS:455 is used, the compressive strength requirements for various grades of concrete, controlled as well as ordinary shall be as given in Table-1. Where rapid hardening Portland cement is used, the 28 days compressive strength requirement specified in Table-1 shall be met at 7 days. For controlled concrete, the mix shall be so designed as to attain in preliminary tests, a strength at least 33 percent higher than that required on work tests, for concrete mix upto and including M-300 and 25 percent higher for higher strengths. Preliminary tests need not be made in case of "ordinary concrete".

Grade of concrete	Compressive work strength in Kg/cm ² on 150 mm cubes as per Testing conducted in accordance with IS:516.	
	min. at 7 days	min. at 28 days
M-100	70	100
M-150	100	150
M-200	135	200

Tender for Up-gradation of 10 MLD out of existing 18.5 MLD CETP		
M-250	170	250
M-300	200	300
M-350	235	350

Note: In all cases, the 28 days compressive strength specified in Table-1 shall be the criterion for acceptance or rejection of the concrete.

When the strength of a concrete mix as indicated by test, lies in between the strength for any two grades specified in Table-1 such concrete shall be classified for all purpose as concrete belonging to the lower of the two grades between which its strength lies.

Field Test cubes shall be taken as per IS 456 required / or directed by Engineer In Charge. The same shall be tested in approved laboratory & results shall comply with required strength of mix used. The cost of taking cubes and testing shall be included in rates quoted.

[2] Nominal Mix Concrete:

Under special circumstances nominal mix concrete for grades of M20 or lower may be used with prior approval of Engineer-in-charge. Nominal Mix concrete shall be as per Table 9 of IS 456:2000

5.31.7 Construction Tolerances

(a) Length		
(i)	Members up to 3 mt length	+ 3mm to -6mm
	3 mt to 4.5 mt length	+ 3mm to -8 mm
	More than 4.5 mt length	+ 3 mm to -10mm
(b) Cross-Sectional Dimensions		
	Dimensions up to 15 cm	+ 2mm
	Dimensions between 15 cm and 23 cm	+ 3mm
	Dimensions greater than 23 cm	+ 4mm

Straightness : When a straight edge or line is applied to the member it shall not show concavity or convexity exceeding.

For length up to 4.5 mt	4.5 mm
For length between 4.5 mt	6.0 mm
For length exceeding 6 mt	8.0 mm

Shape of Cross Section – No line on the cross section of a member shall deviate from its correct position by an angle exceeding 1 Degree. Vertical members shall not deviate in verticality from its true position by more than 5% of vertical length subject to maximum of 20 mm.

Member which do not confirm to above mentioned constructional tolerances shall be removed and redone or modified / strengthened as per instructions of Engineer-in-charge / Consultant.

5.31.8 Specifications For Formwork, Centering & Scaffolding

- Materials :
 - Formwork shall be in plywood, sawn timber or steel as required for shaft, container walls, stairs, slab, beams, columns, parapets, etc. for all concrete work.
- Workmanship :
 - The formwork shall conform to the shape, lines and dimensions as shown on the drawings and shall be so constructed so as to remain sufficiently rigid and water-tight, during placement and compaction of the concrete. Adequate arrangement shall be made by the Contractor to safe guard against any settlements of the formwork during the course of concreting and after concreting.
- Centering :
 - The centering, which has been got approved should be sufficiently strong and safe before, during and after pouring concrete and should be so erected that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.
 - The props of centering shall be provided on firm foundation or base of sufficient strength to carry the loads, without any settlement.
- Scaffolding :
 - All scaffolding, hoisting arrangements and ladders etc, required for facilitating of concrete shall be provided and removed on completion work by Contractor, at his own expense. The scaffolding, hoisting arrangement, ladders etc shall be strong enough to withstand all live, dead and impact loads expected to act. The Contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangement, ladders, work and workmen etc.
 - The scaffolding, hoisting arrangement and ladders shall allow easy approach to the work spot and afford easy inspection.

5.32 Ready Mix Concrete:

1. Concrete mix shall be design for 33% higher strength than the grade of concrete specified. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available.

Except where it can be shown to the satisfaction of the Engineer-in-charge that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be strictly controlled. The different sizes, shall be stocked in separate stock piles. Required quality of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the design mix.

The quantity of both cement and aggregate shall be determined by weight. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean, and serviceable condition. Their accuracy shall be periodically checked.

It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, the moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS:2386 (Part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

The special conditions / Specifications regarding RMC are as follows.

1. The details like location, capacity, experience, delivery schedule etc. of the RMC agency shall be submitted by the successful tenderer for prior approval of the Engineer In-Charge/PMC/TPI of CLIENT.
2. The RMC shall be conforming to IS 4926 with its latest amendments.
3. All the responsibility of RMC i.e. procurement of all materials, operation of plant and machinery, transit mixers, pumping machineries relevant piping etc. shall be on the account of the contractor.
4. The CLIENT Shall not be held responsible for any delay / damage / loss due to deployment of RMC for this project.
5. All taxes applicable including VAT for the RMC shall have to be borne by the contractor as per prevailing rates.
6. RMC process shall be fully automatic and computerized.
7. When a transit mixer is used for transportation of concrete, no extra water should be added to the concrete from else where after initial introduction of mixing water from the batch, except when on arrival at the site of the work, the slump of the concrete is less than that specified: such additional water to bring the slump within required limits shall be injected into that specified: such additional water to bring the mixer under such pressure and direction of flow that requirements for uniformity are met.
8. Records and Certificates: The contractor shall keep from the manufacture batch records of the quantities by mass of all the solid materials, of the total amount of water used in mixing and of the results of all tests. If required by the CLIENT, the contractor shall furnish certificates, at agreed intervals, giving this information.
9. The contractor shall supply the following information for guidance of the manufacturer:
 - a. The type of cement to be used
 - b. Details Specifications of aggregates to be used.
 - c. Type of admixture to be used, if specified
 - d. Min. acceptable strength
 - e. Slump of concrete or compacting factor
 - f. Ages at which the test cubes or beams are to be tested, and the frequency and number of test to be made

g. Any other requirement

10. Tolerance: Unless otherwise agreed to between the PMC of CLIENT and the contractor, the concrete shall be deemed to comply with the requirements of this, if there results of testes where applicable lie with in the tolerance specified below.
 11. Consistency of workability: The slump average of two test shall not differ from the specified value by + 10 mm for a specified slump of 75 mm. The compacting factor average of two tests shall be within + 0.03 of the value specified. If any other method of determining consistency to be used a suitable tolerance shall be agreed to be between the purchaser and the manufacture. The tests for consistency or workability shall be complete within 15 minutes of the time of receipt of the ready mix concrete at the site.
 12. Aggregate- When tested in accordance with IS 2386 (part-I) 1963, the quantity of aggregate larger than the max size specified by the purchaser shall not exceed 5% of the qty. of coarse aggregate and all such excess shall pass sieve of next higher size.
2. The water cement ratios shall be not more than those specified .The cement content of the mix specified shall be increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction so that the water-cement-ratio specified in the Schedule-A is not exceeded.

Workability of the concrete shall be controlled by maintaining a water-cement-ratio that is found to give a concrete mix which is just sufficiently wet to be placed and compacted without difficulty with the means available.

The maximum size of coarse aggregate shall be as large as possible within the limits specified but in no case greater than one fourth of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and to fill the corners of the form.

For reinforced concrete work, coarse aggregate having a nominal size of 20 mm. are generally considered satisfactory.

For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of coarse aggregate should usually be restricted to 5mm. main bars, or 5 mm. less than the minimum cover to the reinforcement whichever is smaller.

Where the reinforcement is widely spaced as in solid slabs, limitations of size of the aggregate may not be so important, and the nominal maximum size may sometimes be as great as or greater than the minimum cover.

No materials other than the essential ingredients, i.e., cement, aggregates and water, shall ordinarily be used in the manufacture of concrete or mortar. But the Engineer-in-charge may permit the use of approved admixtures for improving the workability of the concrete, if so specified, on satisfactory evidence that its use does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no deleterious effect on the reinforcement. Admixtures where allowed shall conform to relevant IS:9103.

Chloride content in admixture shall be independently tested for each batch before acceptance.

Quantity of Water:

The quantity of water shall be just sufficient to produce a dense concrete of required workability and strength for the job. An accurate and strict control shall be kept on the quantity of mixing water.

In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips, all reinforcements. The degree of consistency, which shall depend upon the nature of work and the methods of vibration of concrete, shall be determined by regular slump tests. The following slump shall be adopted for different types of works or as directed by the Engineer-in-charge.

Sr. No.	Type of Work	Where vibrators are used
1.	Mass concrete in RCC foundations, footings and vertical walls.	10 mm to 25 mm
2.	Beams, slabs and columns simply reinforced.	25 mm to 40 mm
3.	Thin RCC Section or Section with congested steel.	40 mm to 50 mm

NOTE: With use of ordinary concrete the slump requirement specified above would not be applicable.

3. Workmanship

3.1 Formwork

The form work shall conform to the shape lines and dimensions as shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to safeguard against any settlement of the form work during the course of concreting and after concreting.

The form work of shuttering, centering, scaffolding, bracing etc. shall be as per design.

Cleaning & Treatment of forms

All rubbish, particularly chippings shaving and saw dust shall be removed, from the interior of the form before the concrete is placed and the form work in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively a coat of raw linseed oil or form oil of approved manufacturer may be applied in case of steel shuttering is used. Soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Care shall be taken that the coating does not get on construction joint surfaces and reinforcement bars.

Stripping Time

In normal circumstances and where ordinary cement is used forms may be struck after expiry of following periods ---

a] Sides of walls columns & vertical faces of beams	2--4 Days
b] Beam soffits (props. left under)	7 Days
c] Removal of props slabs	
i] Slabs spanning up to 4.5 Mts.	7 Days
ii] Spanning over 4.5 Mts.	14 Days
d] Removal of props to beams and Arches	
i] Spanning up to 6 Mts.	14 Days
ii] Spanning over 6 Mts.	21 Days

Procedure when removing the form work

All form work shall be removed without such shock or vibration as would damage the reinforced concrete surface. Before the soffit form work and struts are removed, the soffits and the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened.

Centering

The centering to be provided shall be got approved. It shall be sufficiently strong to ensure absolute safety of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see that behavior of centering and form work is satisfactory during concreting.

Erection should also be such that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.

Scaffolding

All scaffolding, hoisting arrangements and ladders etc. required for the facilitating of concreting shall be provided and removed on completion of the work by the contractor at his own expenses. The scaffolding, hoisting arrangements and ladders etc. shall be strong enough to withstand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge. However, the contractor shall be solely responsible for the safety for the scaffolding, hoisting arrangements, ladders, work and workmen etc.

The scaffolding, hoisting arrangements and ladders shall allow easy approach to the work spot and afford easy inspection.

Re-use

Before re-use, all forms shall be inspected by the Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints gone over, repaired where required. Inside surface shall be retreated to prevent adhesion of concrete.

Reinforcement

The bars shall be kept in position by the following methods-

- i] In case of beam and slab construction, sufficient number of pre cast cover blocks in cement mortar 1:2 (1 cement, 2 coarse sand) about 4 x 4 cms. section and of thickness equal to the specified cover shall be placed between the bars and shuttering as to secure and maintain the requisite cover of concrete over the reinforcement.
- ii] In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them, the templates shall be removed after concreting has been done below it. The bars may also be suitably tied by means of annealed steel wires to the shuttering to maintain their position during concreting.

All bars projecting from pillars, columns beams slabs etc. to which other bars and concrete are to be attached or bounded to later on, shall be protected with a coat of thin neat cement grout, if the bars are not likely to be incorporated with succeeding mass of concrete within the following days. This coat of thin neat cement shall be removed before concreting.

3.2 Proportioning

Proportioning shall be done by weigh batching, except cement which shall be measured in terms of bags of 50 Kg. weight.

3.3 Mixing

For all works, concrete shall be mixed in a mechanical mixer which along with water controlling unit (water gauge) and other accessories shall be kept in first class working condition and so maintained throughout the construction. Measured quantity of aggregate, sand and cement required for each batch shall be poured into the drum of the mechanical mixer while it is continuously running. After about half a minute of dry mixing measured quantity of water required for each batch of concrete mix shall be added gradually and mixing continued for another one and a half minute. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons, it shall be done on a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign materials gets mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Specified quantity water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased

by 10% above that specified.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Engineer-in-charge the first batch of concrete from the mixture shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

3.4 Consistency

The degree of consistency which shall depend upon the nature of the work and methods of vibration of concrete, shall be determined by regular slump tests in accordance with I.S. 1199-1959. The slump of 10 mm. to 25 mm. shall be adopted when vibrators are used and 80 mm. when vibrators are not used.

3.5 Inspection

Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength, alignment, and general fitness but such inspection shall not relieve the contractor of his responsibility for the safety of men, machinery, materials and for results obtained. Immediately before concreting, all forms shall be thoroughly cleaned.

Centering design and its erection shall be got approved from the Engineer-in-charge. One carpenter with helper shall invariably be kept present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited from reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover mortar blocks of suitable size shall be cast and tied to the reinforcement timber, kapachi or metal pieces shall not be used for this purpose.

3.6 Transporting & Laying

The method of transporting and placing concrete shall be as approved. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes place.

All form work shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

Concreting shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer. Except where otherwise agreed to by the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 meters when internal vibrators are used and not exceeding 0.30 meters in all other cases.

Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into placed from a height exceeding 2 meters. When trunking or chutes are used they shall be kept close and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened swept clean, thoroughly wetted, and covered with a 13 mm. thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all fresh water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old work, particular attention being given to corners and close spots.

All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators cannot be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of breakdowns.

Concrete shall be judged to be compacted when the mortar fills the spaces between coarse aggregate and begins to cream up to form an even surface. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to dry mixture. During compaction, it shall be observed that needle vibrators are not applied on reinforcement which is likely to destroy the bond between concrete and reinforcement.

3.7 Curing

Immediately after compaction, concrete weather, including rain, running water shocks, vibration traffic, rapid temperature change, frost and drying out process. It shall be covered with wet sacking Hessian or other similar absorbent material approved soon after the initial set, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over foundation concrete may be started after 48 hours of its laying but curing of concrete shall be continued for a minimum period of 14 days.

3.8 Sampling & Testing Of Concrete

Samples from fresh concrete shall be taken as per I.S. 1199-1959 and cubes shall be made, cured and tested at 7 days or 28 days as per requirements in accordance with I.S. 516-1959. A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested i.e. the sampling should be spread over the entire period of concreting and cover all mixing units. The minimum frequency of sampling of concrete of each grade shall be in accordance with the following

Quantity of Concrete in the work	No. of Samples
-------------------------------------	----------------

1 - 5 Cmt.

1

6 - 15 Cmt.	2
16 - 30 Cmt.	3
31 - 50 Cmt.	4
51 & above	4 + 1 additional sample for each additional 59 m. or part thereof

Note: At least one sample shall be taken from each shift. Ten test specimens shall be made from each sample, five for testing at 7 days and the remaining five at 28 days. the samples of concrete shall be taken on each day of the concreting as per above frequency. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveals a poor quality of concrete and in other special cases.

The average strength concrete in grade M-150, M-200, M-250, M-300 and M-350 of the group of cubes cast for strength of 150, 200, 250 300 and 350 Kg/Cm² respectively at 28 days. 20% of the cubes cast for each day may have value less than the specified strength provided the lowest value is not less than 85% of the specified strength. If the concrete made in accordance with the proportions given for a particular grade does not yield the specified strength, such concrete shall be classified as belonging to the appropriate lower grade. Concrete made in accordance with the proportions given for a particular grade shall not, however, be placed in a higher grade on the ground that the test strength are higher than the minimum specified.

3.9 Stripping

The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike the form work. While fixing the time for removal of form work, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. In normal circumstances (generally where temperatures are above 20 degrees centigrade) and where ordinary concrete is used, forms may be struck after expiry of periods specified for respective item of form work.

All form work shall be removed without causing any shock or vibration as would damage the concrete. Before the soffit and struts are removed, the concrete surface shall be exposed, where necessary in order to ascertain that the concrete has sufficiently hardened, centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal parts shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to re-use the form work, it shall be cleaned and made good to the satisfaction of the Engineer-in-charge. After removal of form work and shuttering, the Engineer-in-charge shall inspect the work and satisfy by random checks that concrete produced is of good quality.

Immediately after the removal of forms, all exposed bolts etc. passing through the cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm. below the surface of the concrete and the resulting holes be filled by cement mortar. All fine caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in proportions used in the grade of concrete that is being finished and of as dry consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which are pointed shall be kept moist for a period of 24 hours.

If rock pockets/honeycombs in the opinion of the Engineer-in-charge are of such an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and required the removal and replacement of the portions of the structure affected.

Construction Joints:- Concreting shall be carried out continuously up to construction joints, the position and details of which shall be as indicated on the drawings or predetermined by the Engineer-in-charge.

When the work has to be resumed on a surface which has hardened, such surface shall be roughened. The surfaces shall then be thoroughly cleaned, and all laitance removed with wire brushes and compressed air. In addition to that, the surface shall be completely wetted and slushed with a coat of neat cement grout immediately before placing of new concrete. The first layer of concrete to be placed on these surfaces shall not exceed 150mm in thickness and shall be well rammed against old work, particular attention being paid to corners and close spots. Shear keys shall be provided to all construction joints.

Reinforcing rods shall be extended 35 diameters beyond construction joints unless otherwise indicated. Joints in beams shall be kept at places where the shear force is minimum and these shall be at right angles to the direction of main reinforcement. In the case of columns, the joints shall be horizontal and about 150mm below the bottom of the deepest beam framing into the column head, and the portion of the column between the stopping off level and the top of the slab shall be concreted with the beam.

Joints in the R.C.C. slab shall be provided parallel to main reinforcements, or slabs supported thereon. Beams, girders, brackets, columns capitals and branches shall be considered as part of the floor system and shall be monolithically placed therewith.

Construction joints in water retaining structure: Construction joints for the water retaining structures and underground storage area and lift pits in water logged areas

shall be constructed as detailed out in the drawings and/or as determined by the Engineer-in-charge prior to taking up any work of this type. Work shall conform to I.S. 3370 unless shown otherwise.

Reinforcement in the walls or otherwise shall normally be continued unless otherwise indicated in the drawings.

Standard key joints should, however, be provided if so directed, in addition to the water stoppers in the concrete as specified and shown in the drawing.

The water stoppers shall be PVC or rubber type. Whenever required the transverse joints of the sheets shall either be welded or brased, or overlapped. In case of overlapping of the stoppers the overlap should be minimum and equal to the width of such water stoppers. In case of the PVC or rubber water stoppers, the stoppers can be of approved make.

Deposition and compaction of concrete prior and after the construction joint should be very carefully done, so as to avoid internal honey combing. Before the next pour of concrete, the joints should be cleaned of the loose mortar, aggregates dust, preferably by hosing down the water. The surface of the old concrete which is coming in contact with the next pour should be wire brushed and reasonably sprinkled with thick cement slurry so as to ensure proper bond.

Grouting

i] Grouting of Pockets –

The grouting shall be done with C.M. in proportion of one part of Portland cement plus one part of sand and one part of grit (max. size 6 mm.). Adequate quantity of water shall be added. The pockets shall be thoroughly cleaned before fixing the holding-down bolts. In cases where the anchor bolts with sleeves are provided, it shall be the responsibility of the contractor to keep them clean. Similarly, the treaded portion of the bolts shall be greased to protect them from damage. Grout shall be gradually poured in the pockets without disturbing the holding down bolts, and shall be tamped with a steel rod for proper compaction.

ii] Grouting under base plates & machine bases –

The grouting shall be done in C.M. of one part of Portland cement and 2 parts of sand mixed with adequate quantity of water, unless otherwise specified. It shall be worked in and compacted, so that the entire space under base plates and around the anchor bolts is thoroughly filled with the dense grout. Care should be taken that no air bubbles are left inside the grout. The grout shall be cured for a minimum period of 7 days by wetting the exposed areas. The shin plates under the bases should be left undisturbed while grouting is undertaken, prior to grouting, the space under the steel shall be thoroughly cleaned and watered without disturbing the shin plates. The thickness of the grout shall be as per the drawings. No grouting work shall be carried out all the bases are properly aligned and plumbed. After the grouting is done, anchor bolts should be tightened, while

the grout is green till all the air bubbles cease and cement slurry comes out to ensure that the surface of bearing plate is entirely in contact with the grout.

- iii] The rate shall include the grouting of pockets. No extra payment will be made for keeping pockets in R.C.C. and grouting of pockets thereafter.

6.0 Sand Filling :

- 6.1 The sand to be used for filling shall be free from salts, organic or other foreign matter. All clods of sand shall be broken.
- 6.2 As soon as the work in foundation has been completed the site of foundation shall be cleared of all debris, brick bats, mortar dropping etc. sand filled with sand in layers not exceeding 20 Cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The sand shall be rammed with iron rammers where feasible and with the butt ends of crowbars, where rammer cannot be used.
- 6.3 The plinth shall be similarly filled with sand in layers not exceeding 20 cms. adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 6.4 The finished level of filling shall be kept to shape intended to be given to floor.
- 6.5 The sand shall be allowed to be used in filling the trenches and plinth. Under no circumstances black cotton soil be used for filling the plinth.

7.0 Water Proofing Material :

- 7.1 The water proofing compound ("CEM WET") or equivalent) shall conform to I.S. 9103-1979 and shall be approved by the Engineer-in-charge
- 7.2 The water proofing material of approved make shall be added to the cement at the rate of 200 gm. per 50 Kg cement bag or the proportion of water proofing materials to be mixed with 50 kg cement bags shall be as recommended by the manufacturer of the water proofing material and before using it shall be got approved by Engineer-in-charge
- 7.3 The water proofing materials and cement in specified proportion shall be thoroughly mixed till a homogeneous mixture of uniform colour is obtained and to have efficient workability.

8.0 Reinforcement : CRS (corrosion resistant steel) bars conforming to IS 1786 (Fe 500)

8.1.0 MATERIAL:

- 8.1.1 Mild steel bars shall cold twisted steel bars (high yield strength deformed bars) shall, Mild steel binding wires.

8.2.0 WORKMANSHIP:

- 8.2.1 The work shall consist of furnishing and placing reinforcement to the shape and dimensions as shown on the drawings or as directed.
- 8.2.2 Steel shall be clean and free from rust and loose mill scale at the time of fixing in position and subsequent concreting.
- 8.2.3 Bars shall be bent cold to specified shape and dimensions as per IS:2502, using a proper bar bender, operated by hand or power to attain proper radius of bends. Bars shall not be bent or straightened in a manner that will injure the material. Bars bent during transportation or handling shall be straightened before being used on the work. They shall not be heated to facilitate bending. Unless otherwise specified for mild steel a “U” type hook at the end of each bar shall invariably be provided to main reinforcement. The radius of the bend shall not be less than twice the diameter of the round bar and the length of the straight part of the bar beyond the end of the curve shall be at least four times the diameter of the bar. In case of bars which are not round and in case of deformed bars, the diameter shall be taken as the diameter of the circle having an equivalent effective area. The hooks shall be suitably encased to prevent any splitting of the concrete. The cold twisted steel bars shall be used without hooks at the ends. Deformed bars without hooks shall, however, comply with relevant anchorage requirements.
- 8.2.4 All the reinforcement bars shall be accurately placed in exactly the same position as shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1.63 mm. In size, and by using stay blocks or metal chair spacers, metal hangers, supporting wires or other approved devices at sufficiently close intervals. Bars shall not be allowed to sag between supports nor displaced during concreting or any other operations of the work. All devices used for positioning shall be of non-corrodible material. Wooden and metal supports shall not extend to the surface of the concrete, except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing shall not be allowed. Pieces of broken stone or brick wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices. Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To prevent reinforcement from corrosion, concrete cover shall be provided as indicated on drawings. All the bars are to be spliced and which are likely to remain exposed for a period exceeding 10 days shall be protected by a thick coat of neat cement grout.**
- 8.2.5 Bars crossing each other where required shall be secured by binding wires (annealed) of size not less than 1.63 mm. in such a manner that they do not slip over each other at the time of fixing and concreting.**
- 8.2.6 As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm or 1.25 times the maximum size of the coarse aggregate whichever is greater between them. Where not feasible, overlapping bars shall be bound with annealed wires, not less than 1.63 mm. thick, twisted tight. The overlaps shall be

staggered for different bars and located at points, along the span where neither shear nor bending moment is maximum.

- 8.2.7 Wherever indicated on the drawings or desired by the Engineer-in-charge bars shall be joined by couplings which shall have a cross section sufficient to transmit the full stresses of bars. The ends of the bars that are joined by coupling shall be upset for sufficient length so that the effective cross section at the base of threads is not less than the normal cross section of the bar. Threads shall be standard threads. Steel for coupling shall conform to IS-226.
- 8.2.8 When permitted or specified on the drawings, joints of reinforcement bars shall be butt-welded so as to transmit their full stresses. Welded joints shall preferably be located at points where steel will not be subjected to more than 75% of the maximum permissible stresses and welds so staggered that at any one section not more than 20% of the bars are welded. Only electric welding using a process which excludes air from molten and conforms to any or all other special provisions for the work shall be accepted.

Suitable means shall be provided for holding bars securely in position during welding. It shall be ensured that no voids are left in welding and when welding is done in two or three stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M.S. electrodes used for welding shall conform to I.S. 814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of test shall be as directed.

9.0 Fabrication Work :

- 9.1 The structural steel work shall conform to M-18, red lead paint primer shall conform to I.S.-102-1962.
- 9.2 The steel sections as specified or required shall be cut, square and to correct lengths. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member, except as permitted prior to starting of work as directed. All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in such a manner so as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed/permitted.
- 9.3 The steel structure as per direction of the Engineer-in-charge shall be laid out on a level platform to full scale and in size or parts. A steel tape shall be used for measurements to ensure maximum accuracy.
- 9.4 Welding shall generally be done by electric process. Gas welding shall be resorted to, using oxyacetylene flame with specific prior approval. Gas welding shall not be permitted for structural steel work.
- 9.5 The welding work shall conform to I.S. 816-1969.

- 9.6 Preparation of surfaces : Surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.
- 9.7 Assembly for welding : Before welding is commenced, the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the plates accurately in place without displacement.
- 9.8 Precautions : All operations connected with welding and cutting equipment shall conform to safety requirements given in I.S.-1118-1968.

The following points shall be borne in mind during the process of welding

- a] Welds shall be made in flat position wherever practicable.
- b] Arc length, voltage and amperage shall be suited to the thickness of material type of groove & other circumstances of the work.
- c] The segments of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.
- 9.9 The defective welds which shall be considered harmful to the structural strength shall be cut out and re welded.
- 9.10 Finished welds and adjacent parts shall be protected with clean boiled linseed oil and after all slag has been removed welds and adjacent parts shall be painted after the same are approved.
- 9.11 All the members shall be thoroughly cleaned, of rust, scales, dust etc. and given a priming coat of red lead paint before fixing them in position. Testing of welding to be added in the specification I.N. 12.2.2.12-(i) to (viii).

10.0 Brick Work :

Using fly ash bricks confirming to IS-13757-1993, IS-5454, IS- 3495, IS - 12894 building bricks having crushing strength not less than 70 Kg/Sq.cm² in cement mortar 1:6 (1 cement : 6 fine sand)

10.1.0 Materials

Water shall conform to M-1, Cement shall conform to M-3, Sand shall conform to M-5, Fly ash Bricks shall conform to IS 13757, IS 5454, IS 3495, IS 12894 Cement mortar shall conform to M-8.

10.2.0 Workmanship

10.2.1 Proportion : The proportion of cement mortar shall be 1:4 (1 cement : 4 fine sand) by volume.

10.2.2 Wetting of bricks : The bricks required for masonry work shall be thoroughly wetted with clean water for about two hours before use or as directed. The cessation of bubbles, when the bricks are wetted with water, is an indication of thorough wetting of bricks.

10.2.3 Laying : Bricks shall be laid in English bond unless directed otherwise. Half or cut bricks shall not be used except when necessary to complete the bond. Closures in such case shall be cut to required size and used near the ends of the walls.

A layer of mortar shall be spread on full width for suitable length of the lower course. Each brick shall first be properly bedded and set home by gently tapping with handle of trowel or wooden mallet. Its inside face shall be flushed with mortar before the next brick is laid and pressed against it. On completion of course, the vertical joints shall be fully filled from the top with mortar. The walls shall be taken up truly in plumb. All courses shall be truly horizontal and all vertical joint shall be truly vertical. Vertical joints in alternate course shall generally be directly one over the other. The thickness of brick course shall be kept uniform. Thickness of mortar bed shall be 6 to 8mm.

The brick shall be laid with frogs up wards. A set of tools comprising of wooden straight edges, mason's spirit level square, half meter rub, and pins, string and plumb shall be kept on the site of work for frequent checking during the progress of work.

Both the faces of walls of thickness greater than 23 cms. shall be kept in proper place. All the connected brick work shall be kept not more than one metre over the rest of the work. Where this is not possible, the work shall be raked back according to bond (and not left toothed) at an angle not steeper than 45 degrees.

All fixtures, pipes, outlet of water, hold fasts of doors and windows etc. which are required to be built in wall shall be embedded in cement mortar.

10.2.4 Joints : Bricks shall be so laid that all joints are quite flush with mortar. Thickness of joints shall not exceed 12 mm. The face joints shall be raked out as directed by raking tool daily during the progress of work, when the mortar is still green so as to provide key for plaster or pointing to be done.

10.2.5 Curing : Green work shall be protected from rain suitably, Masonry work shall be kept moist on all the faces for a period of seven days. The top of masonry work shall be kept well wetted at the close of the day.

10.2.6 Preparation of Foundation Bed : If the foundation is to be laid, directly on the excavated bed, the bed shall be leveled, cleared of all loose materials, cleaned and wetted before starting masonry.

If masonry is to be laid on concrete footing, the top of concrete shall be cleaned and moistened. The Contractor shall obtain the Engineer's approval for the foundation bed,

before foundation masonry is started. When puccas flooring is to be provided flush with the top to plinth, the inside plinth offset shall be kept lower than the outside plinth top by the thickness of the flooring.

- 10.2.7 Fixtures – The frames of doors, windows, cup-boards etc. shall be housed into the brick work at the correct location and level as directed. The heavy steel doors, window frames etc. shall be built in with brick work, but for ordinary steel doors and windows required opening for frames, hold – fasts etc. shall be left in the wall and frames embedded later on in order to avoid damage to the frames.
- 10.2.8 Scaffolding –Necessary scaffolding shall be provided. The supports shall be sound and strong tied together with horizontal places, over which the scaffolding planks shall be fixed. Simple scaffolding shall be allowed normally. In this case scaffolding hole shall rest in hole header horizontal course only. Minimum number of holes shall be left in brick work for supporting horizontal scaffolding poles. The Contractor is responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads likely to come upon it.
- 10.2.9 Packing out of joints – For the face of brick work, where plastering is to be done, joints shall be raked out to a depth not less than thickness of joints. The face of brick work shall be cleaned and mortar dropping removed on very same day that brick work is laid.

11.0 Un coursed Rubble Masonry :

Providing un coursed rubble masonry work, cement mortar 1:6 up to plinth level including providing scaffolding, curing, racking out joints including all labour and material.

- 11.1 Stone :
Stone shall be of approved quality. It shall be sound, uniform in colour and free from decay and weathering, stone with round surface shall not be used. Unless otherwise approved, stones from one single quarry shall be used for any one work.
- 11.2 Dressing :
Stone shall be hammer dressed on the face and sides. The "bushing" on the face shall not project more than 20 mm on an exposed face and 15 mm on an exposed face and 15 mm on the face to be plastered.
- 11.3 Mortar :
The mortar to be used for jointing shall be as specified in the schedule of rates.
- 11.4 Laying :
All stones shall be wetted before use. They may be laid at random without being brought up to any level except at plinth. The bond shall be obtained by fitting in closely the adjacent stones and by using bond stones. Bond stones shall extend and bond well into the backing. Proper breaking of joints shall be done. Their height shall not be greater than the breadth at face or the depth inward. Interior filling of the wall face shall consist of rubble stones not less than 130 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar.

No hollow space shall be left anywhere in the masonry chips not more than 20% of quantity of stone masonry may be used in the interior to fill interstices between adjacent stones in hearting wherever necessary to avoid thick mortar bed or joints. At about one meter interval vertical "plumbs", projecting upward about 50 to 200 mm shall be firmly embedded to form a bond between successive courses. The masonry in a structure shall be carried regularly.

11.5 Bond stone :

Bond or through stone running right through the thickness of wall shall be provided in the walls having thickness up to 600 mm. If the walls are thicker than 600 mm, two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. At least one bond stone or a set of bond stones shall be provided for every 0.5 sq.m. of wall surface.

11.6 Quoins :

The quoins shall be of selected stones neatly dressed to the required angle and shall be of the same height as the course in which they occur and laid header and stretcher alternately. No quoin stone shall be less than 0.03 cum

11.7 Joints :

Stones shall be so laid that all joints are full of mortar. Face joints shall vary from 12 mm to 25 mm thick, but not less than 12 mm. Joints shall be raked to a depth of 20 mm during construction, if walls are to be plastered or pointed. For the faces of wall which are not to be plastered stone surfaces shall be cleared of mortar dropping to give uniform appearance.

11.8 Curing:

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly wet for a minimum period of 10 days.

12.0 Plaster :

12.1 Inside plaster:

Inside Cement plaster shall be of 20 mm thick cement plaster with approved water-proofing compound in water retaining part of all units, including free board portion with cement mortar 1:3 (1 Cement : 3 fine sand)

12.1.1 Materials:

Water shall conform to M-1 Cement mortar shall conform to M-8.

12.1.2 Workmanship.

[1] The work shall be carried out in two coats. The backing coat (basecoat) shall be 12 mm. thick in C.M. 1:3. The thickness of back coat shall be 12 mm. average and the proportion shall be of cement mortar 1:3 (1 cement : 3 sand). Before the first coat hardens its surface shall be beaten up by edges of wooden tappers and close dents shall be made on the surface. Subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days, depending upon the weather conditions. The surface shall not be allowed to dry during this period.

The second coat shall be completed to 8 mm thickness in C.M. 1:1 as described above, including raising, sand facing by brushing. The sample of plaster shall be got approved before the work is started. The whole work shall be carried out uniformly as per approved sample.

[2] Curing:

The curing shall be started overnight after finishing of plaster. The plaster shall be kept wet for a period of 7 days. During this period, it shall be protected from all damages.

[3] The sand face plastering up to 10 mt. above ground level shall be measured and paid under this item.

12.2 Scaffolding - Wooden bellies, bamboos, planks, treatles and other scaffolding shall be sound. These shall be properly examined before erection and use. Stage scaffolding shall be provided for ceiling plaster which shall be independent of the walls.

12.3 Preparation of Background - The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surface be roughened by wire brushing if it is not hard and hacking if it is hard. In case of concrete surface, if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface. Trimming of projections on brick/concrete surfaces where necessary shall be carried out to get an even surface.

Raking of joints in case of masonry work where necessary shall be allowed to dry out for sufficient period before carrying out the plaster work.

The work shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry, such areas shall be moistened again.

12.4 15 mm thick inside smooth cement plaster shall be applied in all parts of super-structure and inside the buildings on wall, as per above specifications in C.M 1:3.

12.5 10 mm thick inside smooth cement plaster shall be applied underneath of ceilings & soffits etc., of slabs, stair-cases, as per above specifications in C.M 1:2.

12.6 **Outside plaster:-**

Providing and applying 20 mm. thick sand faced cement plaster on walls up to height 10 meters above ground level consisting of 12 mm. thick backing coat of C.M. 1:3 [1 cement:3 sand and 8 mm. thick finishing coat in C.M.1:1 [1 cement:1 sand] etc. comp.

Materials :-

Water shall conform to M-1 cement mortar shall conform to M-8.

Workmanship :-

The work shall be carried out in two coats. The backing coat [basecoat] shall be 12 mm. thick in C.M. 1:3. The thickness of back coat shall be 12 mm. average and the proportion

shall be of cement mortar 1:3 [1 cement:3 sand]. Before the first coat hardens its surface shall be beaten up by edges of wooden tappers and close dents shall be made on the surface subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days, depending upon the weather conditions. The surface shall not be allowed to dry during this period.

The second coat shall be completed to 8 mm thickness in C.M. 1:1 as described above, including raising sand facing by bushing. The sample of sand face shall be got approved before the work is started. The whole work shall be carried out uniformly as per sample approved.

For external plaster, the plastering operation shall be started from top floor and carried downwards. For internal plaster, the plastering operations may be started wherever the building frame and cladding work are ready and the temporary supports of the ceiling resting on the wall of the floor have been removed. Ceiling plaster shall be completed before starting plaster to walls.

12.6 Application Of Plaster

The plaster about 15 x 15 Cms. shall be first applied horizontally and vertically at not more than 2 meters intervals over the entire surface to serve as gauge. The surface gauges shall be truly in place of the finished plastered surface. The mortar shall then be applied in uniform surface slightly more than the specified thickness then brought to a true surface by working a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally, the surface shall be finished off true with a trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive toweling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering, corners, junctions etc. shall be carried out with proper templates to the size required.

Cement mortar shall be used within half an hour after addition of water. Any mortar or plaster which is partially set shall be rejected and removed forthwith from the site.

In suspending the work at the end of the day, the plaster shall be left out clean to the line both horizontally and vertically. When recommenced the plaster, the edges of the old work shall be scrapped clean and wetted with cement putty before plaster is applied to the adjacent areas to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of the wall and nearer that 15 cms. to any corners or arises. It shall not be closed on the body of features such as plaster bands and cornices not at the corners or arises. Horizontal points in plaster work shall not also occur on parapet tops and copings as those invariably lead to leakage. No portion of the surface shall be left out initially to be packed up later on.

Each coat shall be kept damp continuously till the next coat is applied for a minimum period of 7 days. Moistening shall commence as soon as plaster is hardened sufficiently. Soaking or walls shall be avoided and only as much water as can be readily absorbed shall be used, excessive evaporation on the sunny or windward side of building in hot air to dry weather shall be prevented by hanging mattings or gunny bags on the outside of the plaster and keeping them wet.

13.0 Water Proof Plaster :

- 13.1 The relevant specification of Item No. 12 shall be followed except that the water proofing materials as cement or approved make as per I.S. 9130-1979 shall be added to the cement at the rate specified or as directed by the Engineer-in-charge. The proportion of water proofing materials to be by the manufacturer of the water proofing materials.

14.0 Doors & Windows

14.1 Teakwood Doors, Windows And Ventilations :

- a] Thickness of shutters - 35 mm.
- b] Size of frame - 10 cm x 7 cm.

- 14.1.1 Frames - All members of frames shall be exactly at right angles. The right angle shall be checked from inside surfaces of the respective members.

All members of frames shall be straight without any warp or bow and shall have smooth surfaces well planned on the three sides exposed at right angles to each other. The surfaces touching the wall may not be planned unless it is required in order to straighten up the member or to obtain the overall sizes within the tolerances as specified.

Frame shall have dovetail joints. When clearstory windows is included, it shall be provided by having full length one piece post for door or windows and clearstory window extending the frame on top at the head to the required extent. Horns shall not be provided in the head of the frame. When no sills are provided, the vertical posts of the frame in the ground floor shall be embedded in the sill masonry for 10 cm. on upper floors, the vertical posts shall be fixed in the floor or masonry by forming notches 10 mm. deep. Sight adjustment of spacing as necessary shall be done to have the holdfasts in the joints of masonry course. The frame shall be erected in position and held plumb with strong support from both sides and built in masonry as it is being built. The transom shall be through tenoned in the mortices of the jamb post to the full width of the jamb post and the thickness of the tenon shall be not less than 15 mm.

- 14.1.2 Tolerance - Unless specially mentioned otherwise tolerance of 01 # 1.5 mm. shall be allowed for each wrought face.

- 14.1.3 The tenons shall be closely fitting into the mortices and suitably pinned with wood dowels not less than 10 mm. dia. meter. The depth of rebates for housing the shutter shall be as directed.

- 14.1.4 The contact surface of tenon and mortise shall be treated before putting together with an adhesive of approved make.

- 14.1.5 Minimum number of three holdfasts shall be fixed on each side of door and window frames, one at the centre point and the other two at 30 cms. from the top and the bottom of the frames. In case of window and ventilator frames whose height is less than 1 M. two holdfasts, in each side shall be fixed at quarter points of the frames. The size of each holdfasts shall be 300 x 25 x 6 mm. and of mild steel with split end. The holdfasts shall be fixed with screws to frames.

- 14.1.6 Mild steel hold fasts shall be protected with a coating of coal asphalt tar. The surface of frame abutting the masonry or concrete faces shall be properly treated by applying a coat of approved coating.

Shutters - Paneled shutters shall be constructed in the form of timber frame work of styles and rails with panel inserted of type as specified in the detailed drawings. Panel shall be fixed by providing grooves in the styles and rails. The styles and rails shall be joined to each other by mortise and tenon joints at right angles.

All members of the shutters shall be straight without any warp or bow and shall have smooth, well planned faces at right angles to each other.

The size of styles and rails shall be as per drawings or as directed. Styles and rails of shutters shall be made of one piece only.

Timber Paneling - Thickness of the panel shall be as specified in the drawings or as directed. If the panel is made from more than one piece, the piece shall be finished as shown in the detailed drawings and shall be joined with continuous groove with specified size. The end pieces of the panel and the top and the bottom of the panel shall be provided with continuous tongue to frame into groove of the frame shutter. An air space of 1.5 mm. shall be left in the groove of frame of shutter while framing the panel in it.

The faces of the panel as well as various pieces of the panel shall be closely fitted to the sizes of the grooves. Finishing of the corners or raised panel edge shall be done as shown in drawings or as directed. The thickness specified shall be finished thickness and no tolerance will be permitted.

Glazing - The glass panels shall be embedded in putty and secured to the rebate by wooden beads, or moldings shape and size as approved with counter sunk screws of suitable size.

The glass panel shall be properly cut to fit the rebate of the frames and sashes fully with a slight minus margin of about 1.5 mm. of all sides. Before glazing the frame shall be primed and prepared for painting so that wood may not draw oil out of putty. The rebate shall be putted to an extent to provide bedding all round the glass.

The glass shall then be bedded in putty and fitted to frames with wooden beads or molding as directed and screwed with wooden beads or molding as directed and screwed with counter sunk screws. The screws shall be spaced not more than 100 mm. from each corner and nor more than 200 mm. apart.

The size of the rebate in the frame and size and shape of beads or molding shall be as per detailed drawing or as directed. The beads or moldings shall have mitred corners.

Fixtures & Fastenings - All fixtures and fastening of approved quality shall be provided with necessary screws. The hinges, bolts and other items chromium plated of iron mongery with moving part shall be properly oiled by the contractor before handing over the building.

14.1.7 Painting - The surface shall be cleaned and rubbed with sand paper to bring it in the one plane. When finished, no scratches from the sand paper should show. After preparing the surface, one coat of white paint shall applied as priming coat.

After priming coat, all small holes, cracks, open joints and similar other minor defects of every kind shall be stopped with putty made from pure whitening mixing to the appropriate consistency with raw linseed oil.

Little white lead being worked in other mixing to help hardening of putty. The work shall be rubbed down smooth with sand paper and the consequent coats of paint of the specified shade approved by the Engineer-in-charge shall be applied.

The paints shall be applied with brush. It shall be spread as smoothly as possible. Final coat shall be very smooth crossed and laid off, so that brush marks are not visible.

Each coat of paint shall be allowed to dry thoroughly and shall be little rubbed in before the next one is laid.

Finish surface shall not show any hair marks ridges or dry patches of paint and no puddles shall be left in the corners of panels, angles of the moldings etc.

14.2 Aluminum Doors & Windows

14.2.1 Heavy Duty Sliding Windows

14.2.1.2 Aluminum windows and doors to be fixed in the work shall be manufactured using suitable heavy gauge (3.2 mm) Aluminum extruded sections of Indal & Jindal anodized to natural satin finish for 18 to 20 micron. For any work whose purpose made steel windows are specified, the same shall be obtained from Alumilite or Jindal or any other approved manufacturer. The Engineers approval for windows to be supplied by non-specified manufacturer shall be obtained in writing on the Contractor furnishing him at his own cost a sample of each window or door type. Only then a firm order shall be placed with the approved manufacturer. All windows and doors shall confirm to the samples so approved.

14.3 Materials

1 Window:

Heavy duly sliding windows shall be made from extruded aluminum sections of alloy HF:9 – WF of IS :733-1956. Height of the windows shall not be more than 1900 mm. or as specified

2. Frames

Frames shall be 2 or 3 track as required having in built grooves to accept weather strip for weather sealing.

3. Shutters

The shutter vertical, interlock sections shall be hollow sections and horizontal sections shall be non –hollow and suitable for glazing with PVC gaskets. Interlock section shall have in-built grooves for weather stripping.

4. Gutters and valves

In heavy rainfall areas, the sill member shall be hollow section with special gutter section clipped on to the bottom track so as to have hollow chamber of minimum cross – sectional area of 1000 sqm for 2 track and 1500 sq.mtr. For 3 track. The slots of size 75 x 5 mm shall be

Tender for Up-gradation of 10 MLD out of existing
18.5 MLD CETP

provided in the bottom tracks and gutter sections for vertical drainage of rain water. PVC valves shall be provided in the gutter sections acting as pressure equalization cum non-return valves.

5. Section Sizes and other requirements

1. Doors and Windows

Item	Size
Frame- 2track on the slides, top & bottom	63.5 x 34.4 x 1.4 mm
Frame- 3track on the slides, top & bottom	94.6 x 34.4 x 1.5 mm
Shutter- Vertical. Interlock, Horizontal	43 x 20x 1.4 mm

Glazing gaskets soft PVC glazing gaskets shall be used for glazing the shutters. Rubber gaskets shall not be allowed.

Weather strip: soft PVC weather strips shall be provided in the in-built grooves of the sections and rubber weather strips shall not be allowed. Use of pile weather strips in lieu of PVC is optional.

Hardware : The sliding shutters shall be provided with :

- (a) Needle bearing nylon rollers, encased in plated MS brackets.
- (b) Flush type handle- cum lock having aluminum body and stainless steel spring / receiving latch
- (c) Nylon and cover – cum guide on the top and bottom of the shutters.
- (d) Nylon anti lift with pile insert to prevent lifting and tilting of the shutters.

Construction : The frame shall be mechanically jointed with 3 mm thick aluminum angle cleats. The shutters shall be mechanically jointed with plated self tapping screws and aluminum safely plate or aluminum alloy blind rivet and nickel plated self tappingtwo shall be used for the joints and fittings.

Anodizing : The aluminum sections shall be brushed and anodized to natural matte finish or electro colour anodized to any shade of bronze as per IS : 1868 – 1968. For general interior & exterior use the anodizing shall be average 18 to 20 microns. For highly corrosive environment, anodizing shall be average 18 to 20 microns. Gummed paper tapes shall be provided on the exposed surface of the sections as protective coating.

2. Openable Louvered Windows

Material : Heavy duty made from aluminum extruded section HE-9-WP of IS 733

Frame : 40 x 23 x 1.4 mm in built top and bottom repeated sections 40 x 23 x 12 mm

Coupling : Coupling bar panel shape 12.5 x 6 x 2 mm bar

Louvers blade clip : one piece 18 gauge above sheets riveted to jambs by 89 mm c/c, after fixing the blade from inside and attached to coupling bart.

Ground glass : 4 mm thk for louver up to width of 760 mm and 5.5 mm thk for louvers above 760 mm

Weather strips : Soft P.V.C weather strip

Hardware : Louvers window with self locking type handle

Construction & Anodizing : Shall be average 18 to 20 micron and gum paper tape provided to sections as protective coating

3. Medium range Openable & fixed Windows

Material : Heavy duty made from aluminum extruded section HE-9-WP of IS 733

Frame : frames shall have in built grooves to accept the weather strip for weather sealing

Shutters Vertical interlock will be hollow section. Horizontal shall non hollow suitable for glazing with suitable gaskets.

Section

Frame : Equal log 63.5 x 43 x 1.6 mm

shutter : hollow section 57.4 x 40.0 x 1.6 mm

Mullion : Hollow section 62.0 x 40.0 x 1.6 mm

Glazing : Beading 30x19x1.1 mm

4mm thk : clear glass

Hardware : (Openable shutter)

- a. Heavy duty alum butt hinges, having stainless steel pins, dowels & PC washer
- b. Peg stay – Aluminum extruded section
- c. Aluminum fasteners angle with nylon striking plate

Construction & Anodizing

Same as general specification of Sliding window.

4. Doors

Material : Heavy duty made from aluminum extruded section HE-9-WP of IS 733

Frame : Outer frame including intermediate horizontal & vertical members . Members shall be rectangular extruded section for whether shipping

Shutters : Shutters horizontal and vertical section provision for snaps on glazing. Vertical section have mullion groove beading shipping .

Glazing : Screw less snap or square aluminum above beading with PVC, glazing gasket 5.5 mm thk. Clear glass

Section : Outer frames including intermediate horizontal and vertical member size 101.6 x 44.5 x2 mm

Shutter vertical ; 57 x 44.5 x 2.2 mm
Shutter Top ; 48 x 44.5 x 2.2 mm
Shutter Bottom ; 100 x 44.5 x 2.2 mm
Square above beading : 16 x 15.5 x 1.2 mm

Hardware :

- a. Lever lock, brass body key operating from both sides
- b. Standard push and pull horizontal full length
- c. Double action hydraulic floor spring of approved make an quality with G.I. top and bottom pivots

Construction :

Frame : Frame shall be mechanically jointed with 3 mm thk aluminum cleat

Shutter : Mechanically jointed with plated self tapping screws and aluminum safety plates blind rivets and nickel plated self tapping for joints and fitting

Anodizing : Shall be average 18 to 20 microns and gum paper tape provided opt. sections as protective coating

15.0 Shutters

- 15.1 **Rolling Shutter** - The rolling shutter shall conform to I. S. 6248-1979. Rolling shutter shall be supplied of specified type with accessories. The size of the rolling shutter shall be as required & as directed. The shutter shall be constructed with interlocking plate sections formed from cold rolled steel shall 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. in width and above unless otherwise specified.

Guide channels shall be of mild steel deep channel section & of rolled pressed or built up(fabricated) joint less construction. The thickness of sheet shall not be less than 3.15 mm.

The rolling shutter shall be of self rolling type up to 8 Sq.m. clear are without ball bearing and up to 12 Sq.m. clear area with ball bearing. If the rolling shutters are of larger than gear operated type shutters shall be used.

The locking arrangements shall be provided at the bottom of shutters at both ends. The shutter shall be opened from the outside.

The shutters shall be completed with door suspension shafts locking arrangements, pulling hooks, handles and other accessories.

15.2 Collapsible Steel Shutters :

15.2.0 Materials:

- 15.2.1 The collapsible gate shall confirm to M-24.

15.3.0 Workmanship:

- 15.3.1 “T” Rails shall be fixed to the floor and to the lintel at top by means of anchor bolts, embedded in cement concrete of floor and lintel. The anchor bolts, shall be placed approximately at 45 mm centers alternatively in the two flanges of the “T” iron. Iron bottom runner (T-iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible gate shall be fixed at the sites by fixing the end double channels in the T-Iron rail and also by hold – fasts bolted to the end double channel and fixed in the masonry at the side walls or the otherwise.
- 15.3.2 In case where the collapsible gate is not required at the lintel, beams a slope above a T-Iron suitably designed may be fixed at the top embedded in masonry and provided masonry with necessary clamps and roller arrangement at the top.
- 15.3.3 All the adjoining work damaged while fixing gate shall be made good to match the existing work without any extra payment.
- 15.3.4 All members of the collapsible gate including “T” iron shall be thoroughly cleaned to rust, scales, dust etc. and given a primary coat of red lead, before fixing them in position, and after fixing two coats of approved quality oil paint shall be applied.

16.0 Flooring

16.1 20 Mm Thick Marble/Mosaic White Cement Tiles :

- 16.1.1 Bedding - Before spreading the mortar, the sub-base of the floor shall be cleaned of all dirt, scum and loose materials and then well wetted without forming any pools of water on the surface.

In case R.C.C. floors, the top shall be left a little rough. All points of level for the finished surface shall be marked out. The lime mortar of proportion 1:1.5 (1 lime putty : 1.5 fine sand) or cement mortar of proportion C.M. 1:6 as directed shall then be evenly and smoothly spread over the base. Bedding layers of mortar shall be not less than 10 mm. and average thickness of bedding shall be 25 mm.

- 16.1.2 Laying - Before laying the terrazzo (marble/mosaic) tiles. The tiles shall be thoroughly wetted with water. Neat cement grout of required consistency at 4.4 Kg. cement per Sq.m. shall be spread on the mortar bed. The tiles shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope. There shall be no hollows left. The joints shall be of uniform thickness and in straight line as per the pattern.

The surface of flooring shall be checked frequently with a straight edge at least two meters long so as to obtain a true surface with the required slope.

The tiles which are fixed in the floor adjoining the wall shall go about 10 mm. under plaster. Skirting or dado shall be left unfinished for about 50 mm. above finished floor level and unfinished strip then left earlier shall be finished.

In places where full tiles cannot be fixed. The tiles shall be cut to the size and smoothened at edges to give straight and joints.

After the tiles have been laid, the surplus cement slurry and the joints shall be cleaned and washed fairly deep before cement hardens.

The day after tiles have been laid, the joints shall be cleaned of grey cement grout with a wire brush to a depth of about 5 mm. and then grouted with cement with or without pigment to match the shade of the topping of the tiles. The same cement slurry shall then be spread over the whole surface in a thin coat to protect the surface from abrasive damage and to fill pin holes that may exist on the surface.

- 16.1.3 Curing - The flooring shall be kept wet with damp sand or water for seven days. It shall be kept undisturbed at least for 14 days. The grinding shall normally be commenced after 14 days.

Polishing - After the tiles are properly cured, first grinding shall be done with carboundum stone of 48 to 60 gm. grit fitted in machine. Water shall be properly used during grinding. When the chips show up and the floor has been uniformly rubbed, it shall be cleaned with water, bearing all pin holes. It shall then be covered with a thin coat of white cement mixed with or without pigments to match the colour of the topping of the tiles.. Pin holes if any shall thus be filled. This grout shall be kept moist for a week. Thereafter, second grinding shall be started with carborundum of 120 grit. Grouting and curing shall follow again. Final grinding shall be done when other works are finished. The machine shall be fitted with carborundum of grit 220 to 350 using water in abundance. The floor shall then be washed clean with water. Oxalic acid powder shall then be dusted at 33 grams per square meter on the surface and the surface rubbed with machine fitted with hessian bobs or rubbed hard with pad of woolen rags. The floor shall then be washed clean and dried with a soft cloth or linen. The finished floor shall not sound hollow when tapped with mallet.

If any tile is disturbed or damaged it shall be refitted or replaced properly jointed and polished.

Testing of the tiles shall be carried out by the contractor at his own cost as per I.S. requirement for required tests.

16.2 Glazed Tiles :

16.2.1 Material

White / Coloured Glazed Tiles

The tiles shall be of best quality, as approved by the Project Manager and Architects. They shall be flat and true to shape. They shall be free from cracks, crazing spots, chipped edges and corners. The glazing shall be of uniform shade.

Waterproof Adhesive

Waterproof adhesive, shall be of best quality and from manufacturer like Feb Roffe or equivalent, as approved by the Architect and Project Manager. The prior approval for the

source shall be taken from the Architect. It shall conform to the relevant I.S. Code. It shall be in powdered state, complying with BS 5980

Type 2, class AA and BS: 5385 Part 1. It shall comprise of selected Portland cements, graded sand and synthetic additives.

It is useful for permanent adhesion of ceramic tile. It shall provide good tensile adhesion and shear adhesive strength, after application, in thick/thin layer beneath the tile. Its application and coverage shall be as specified by the manufacturer.

16.2.2 Size

The tiles shall be nominal size of 150 mm. x 150 mm, unless otherwise specified. The maximum variation from the stated sizes, other than the thickness of tile shall be + 1.5 mm, The thickness of tile shall be 6 mm. Except for the above, the tiles shall conform to IS : 777-1970.

16.2.3 Execution

Bedding :

The sub-grade shall be cleaned, wetted and mopped. The bedding shall then be laid evenly over the surface, as described above, tamped and corrected to desired level and allowed to harden enough to offer a rigid cushion to tiles and to enable the mason to place wooden planks across and squat on it.

The white/coloured glazed tiles shall then be laid on the cement mortar bedding of specified thickness & in C.M specified. The mortar shall have sufficient plasticity for laying and there shall be no hard lumps that would interfere with the evenness of the bedding. The base shall be cleaned and well wetted, before laying. The mortar shall then be spread in thickness not less than 15 mm. at any place and average as specified. The proportion of the cement mortar shall be as specified in the item.

Fixing tiles :

The tiles before laying shall be soaked in water for at least two hours. Neat grey cement grout at 3.3 Kg.

Cement/m² of honey-like consistency shall be spread over the mortar bedding as directed. The edges of the tiles shall be smeared with neat cement slurry. The tiles shall then be well pressed and gently tapped with a wooden mallet till they are properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints between the tiles shall be as thin as possible in straight line or as per pattern.

The tiles shall not have staggered joints. The joints shall be true to center line both ways. The Nahni trap coming in the flooring shall be so positioned that its grating shall replace only one tile as far as possible.

Where full size tiles cannot be fixed, they shall be cut (Sawn) to the required size and the edges rubbed smooth to ensure straight and true joints. After the tiles are laid, the joints

shall be cleaned of grey cement grout with a wire brush to a depth of about 5 mm. and then grouted with white cement with or without pigment to match the shade of the topping of tiles. The same cement slurry shall then be spread over the whole surface in a thin coat to protect the surface from abrasive damage and to fill up pin holes that may exist on the surface. White cement with or without matching pigment shall be used for pointing the joints. After fixing the tile finally in an even plane the flooring shall be kept wet and allowed to cure undisturbed for 7 days.

While laying, any chiseling which may be required for making the skirting or dado flush with the plaster and/or other finishes shall be done. Necessary grooves of required size between plaster and/or other finishes, dado or skirting (if required) shall be provided. forming machine-cut/rounded edges, gutters, sills, platforms, channels, curbing, etc. if any, if required shall be provided as per the drawing and design.

In places where full tiles cannot be fixed, the tiles shall be cut to the size and smoothened at the edges to give straight and true joints.

All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Architect and Project Manager.

Cleaning :

The surplus cement grout that may have come out of the joints shall be cleared off before it sets. Once the floor has set, it shall be carefully washed and cleaned by dilute acid and dried. Proper precautions and measures shall be taken to ensure that the tiles are not damaged in any way till the completion of the construction.

If any tile is disturbed or damaged it shall be refitted or replaced, properly jointed and cleaned as directed.

16.3 Acid Resisting Brick / Tiling Work :

16.3.1 Materials

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS 4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile / brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile / brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

The tiles / bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

16.3.2 Workmanship

The size and thickness of tiles/ size and class of bricks for use in the flooring/skirting / dado shall be as specified in the respective items of work.

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS: 3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS : 1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC / Stainless steel / chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/ brick. Two adjacent sides of the tile / brick shall be smeared with 4 to 6 mm thick mortar. Tile / brick +shall be pressed into the bed and pushed against the floor and with the adjacent tile / brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/ brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25 % hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of basin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to used for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

16.4 Mirror polish Kota Stone Flooring :

16.4.1 Material

The kotah stones shall be hard, even, sound and regular in shape and generally be uniform in colour.

The colour of the stone shall generally be green. Brown coloured stones shall not be allowed for use. The stones shall be without any soft veins, cracks or flaws.

Tolerance of -30 mm, on accounts of chisel dressing of edges shall be permitted for length as well as breadth. Tolerance in thickness shall be + 3 mm.

The edges of the stones shall be truly chiseled and table rubbed with coarse sand before paving. All angles and edges of the stones of shall be true, square and free from chipping and the surface shall be true and plain.

When machine cut edges are specified, the exposed edges and the edges at joints shall be machine cut.

The thickness of the exposed machine cut edges shall be uniform.

The stones shall have machine polished mirror surface. When brought on site, the stone shall be mirror polished, depending upon its use. Mirror polished kotah stone shall have single face of the stone mirror polished. The stones for paving shall generally be mirror polished. The stones to be used for dado, skirting, sink, veneering, sills, steps, etc., where machine polishing after the stones are fixed in situ, is not possible, shall be polished more than once for the desired finish, before fixing.

When brought at site, the colour of the stone shall be fairly uniform. It shall be ensured that the stones to be used in a particular work shall not differ much in shade or tint, from the approved sample.

16.4.2 Size

The size of the stones to be used for flooring shall be of size 600 mm. x 600 mm and or size 600 mm. x 450 mm, as directed. However, smaller sizes will be allowed to be used to the extent of maintaining required pattern. Thickness shall be, as specified.

16.4.3 Execution

Each slab shall be cut to the required size and shape and fine chisel, dressed at all the edges.

The sides thus dressed shall have full contact if laid along a straight edge. The sides shall be table rubbed with coarse sand, before paving. All angles and edges of the slabs shall be truly square and free from chipping and shall give a plane surface. The thickness of the slab shall be 25 mm. (average) as specified in the item but not less than 20 mm. at any place of the slab.

Bedding for the shall be of cement mortar 1:6 (1 cement : 6 coarse sand) or lime mortar 1:1:5 of average thickness 20 mm. as given in the description of the item. Sub grade shall be cleaned, wetted and mopped. Mortar of the specified mix and thickness shall be then be spread on an area sufficient to receive one kotah slab. The slab shall be washed clean before laying. It shall be laid on top pressed, tapped gently to bring it in level with the other slabs. It shall then be lifted and laid aside. Top surface of the mortar shall then be corrected by adding fresh mortar at hollows or depressions. The mortar shall then be allowed to harden a bit. Over this surface, cement slurry of honey-like consistency shall be applied. The slab shall then be gently placed in position and tapped with wooden mallet till it is properly padded in level with and close to the adjoining slab. The joint shall be as fine as possible. The slabs fixed in the floor adjoining the wall shall enter not less than 10 mm. under the plaster, skirting or dado. The junction between the wall and floor shall be finished neatly. The finished surface shall be true to levels and slopes, as directed.

While laying, any chiseling which may be required for making the skirting or dado flush with the plaster and/or other finishes shall be done. Necessary grooves of required size in cm., between plaster and/or other finishes, dado or skirting (if required) shall be provided. Forming machine-cut/rounded edges, gutters, sills, platforms, channels, curbing, etc. if any, if required, shall be provided as per the drawing and design.

In places where full slabs cannot be fixed, the slabs shall be cut to the size and smoothened at edge to give straight and true joints.

All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Architect and Project Manager.

The floor shall be kept wet for a minimum period of 7 days, so that bedding and joints set properly.

Polishing shall be normally commenced after 14 days of laying the slab. First polishing shall be done with carborundum of 120 grade grit fitted in the heavy machine and then second polishing shall be done with carborundum of 220 to 350 grade grit fitted in the heavy machine. Water shall be properly used during polishing. The flooring shall then be washed clean with water and kerosene. As directed by the Architect and as specified in the item, no waxing will be permitted. However, polishing specifications of marble mosaic terrazzo tiles shall be applicable too.

If any slab is disturbed or damaged it shall be refitted or replaced, properly jointed and polished.

The holes required for Nahni traps, pipes etc or any other fittings shall be made without any extra cost.

16.4.4 Mirror Polishing of Floors (13 to 14 layers) (if polishing is done after fixing of stone)

After the flooring is cured, first grinding shall be done with carborundum of 48 to 60 grade grit (emery)fitted in the machine. Water shall be adequately used during grinding. When the chips show up and the floor has been uniformly rubbed. It shall be cleaned with water, baring all pin holes. It shall then be covered with a thin coat of white cement with or without pigments / grey cement, as the case may be, to match the colour of the topping of the flooring pin holes, if any shall be filled. This grout shall be kept moist for a week. Thereafter, second grinding shall be started with carborundum of 120 grit (emery).

Grouting and curing shall follow again. Third grinding shall be started with carborundum of grit (emery) 220 to 350 and grinding shall be started using water in abundance. To achieve mirror polish finish, more coats of polishing shall be done as approved by the Architect. However, final coat of polishing shall be carried out when all other works are completed. The floor shall then be washed with clean water.

Tin oxide powder shall then be dusted at 33 grams per square meter on the surface and the surface shall be rubbed with a machine fitted with Hessian bobs or rubbed hard with a pad of woolen rags. The floor shall then be washed clean and dried with a soft cloth or linen. However, daily moping with water and kerosene as directed for at least 15 days or up to the satisfaction of Architects and Project Manager.

In no case waxing will be permitted.

16.5 Ceramic Tiles(white or coloured) (rustic / anti skid)

16.5.1 Material

Ceramic tiles shall be of 1st quality such as Romano, Regency, Spartek, Stiles or equivalent, as approved by the Architect and Project Managers. They shall adequately meet the relevant IS.

They shall be light weight, with thickness varying between 6 to 8 mm, depending on the manufacturer.

Therefore, they require thinner floor bedding compared to mosaic/stone flooring. On laying, they require no further polishing making the floor ready to live in and use. They shall be suitably used for residences, offices, hotels, hospitals, auditoriums, restaurants, canteens, commercial complex and such other public places. They shall be extremely strong, breaking strength of the tile being 350 Kg/cm² and flexural strength of 350 Kg/cm². They shall offer good resistance to abrasion, i.e. can withstand up to 5000 grindings. They shall be scratch resistance, their hardness on the Moh's scale shall be 6.8 to 7. They shall be resistant to all acids and alkalies except hydrofluoric acid. In addition, they shall be bacteria free and fire proof, as they are fired at @ 1160°C. They shall have very high acoustic damping factor and their specific gravity shall be 0.12, making them good insulators. Their resistance to thermal shocks shall be up to 10 cycles and their co-efficient of linear thermal expansion shall be 9 from ambient temperature to 100°C.

The Pigment used for mixing with white cement for pointing shall be of Rainbow Tile Mate from Roffe or equivalent as approved.

Thickness of tiles and mortar bedding including its proportion shall be of as specified. Tiles shall be brought and used from, only one source and of the company as approved, for entire work. All materials shall be approved by Architect and Project Manager before use.

16.5.2 Size

They shall be available in various sizes, 8"x4", 8"x8", 8"x12", 12"x 12" and 12"x 16". They shall have a size tolerance of + 0.4% to 0.75%, in length and width and + 5% in thickness. Allowable warpage shall be + 0.5%. Allowable squareness wedging shall be + 0.4 to 0.5%. The allowable straightness of edges shall be + 0.5% and allowable flatness shall be + 0.4 to 0.5%. Their water absorption rate shall be less than 5%.

Ceramic tile for Industrial purposes, shall have a hardness of 8.6 on the Moh's scale and shall be nonskid, hard wearing, long lasting and acid and alkali resistant. They shall adequately meet the IS : 4457.

16.5.3 Execution

Bedding :

The sub-grade shall be cleaned, wetted and mopped. The bedding shall then be laid evenly over the surface, as described above, tamped and corrected to desired level and allowed to harden enough to offer a rigid cushion to tiles and to enable the mason to place wooden planks across and squat on it.

The white/coloured glazed tiles shall then be laid on the cement mortar bedding of specified thickness & in C.M specified. The mortar shall have sufficient plasticity for laying and there shall be no hard lumps that would interfere with the evenness of the bedding. The base shall be cleaned and well wetted, before laying. The mortar shall then be spread in thickness not less than 15 mm. at any place and average as specified. The proportion of the cement mortar shall be as specified in the item.

Fixing tiles :

The tiles before laying shall be soaked in water for at least two hours. Neat grey cement grout at 3.3 Kg.Cement/m² of honey-like consistency shall be spread over the mortar bedding as directed. The edges of the tiles shall be smeared with neat cement slurry. The tiles shall then be well pressed and gently tapped with a wooden mallet till they are properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints between the tiles shall be as thin as possible in straight line or as per pattern.

The tiles shall not have staggered joints. The joints shall be true to center line both ways. The Nahni trap coming in the flooring shall be so positioned that its grating shall replace only one tile as far as possible.

Where full size tiles cannot be fixed, they shall be cut (Sawn) to the required size and the edges rubbed smooth to ensure straight and true joints. After the tiles are laid, the joints shall be cleaned of grey cement grout with a wire brush to a depth of about 5 mm. and then grouted with white cement with or without pigment to match the shade of the topping of tiles. The same cement slurry shall then be spread over the whole surface in a thin coat to protect the surface from abrasive damage and to fill up pin holes that may exist on the surface. White cement with or without matching pigment shall be used for pointing the joints. After fixing the tile finally in an even plane the flooring shall be kept wet and allowed to cure undisturbed for 7 days.

While laying, any chiseling which may be required for making the skirting or dado flush with the plaster and/or other finishes shall be done. Necessary grooves of required size between plaster and/or other finishes, dado or skirting (if required) shall be provided. Forming machine-cut/rounded edges, gutters, sills, platforms, channels, curbing, etc. if any, if required shall be provided as per the drawing and design.

In places where full tiles cannot be fixed, the tiles shall be cut to the size and smoothened at the edges to give straight and true joints.

All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Architect and Project Manager.

Cleaning :

The surplus cement grout that may have come out of the joints shall be cleared off before it sets. Once the floor has set, it shall be carefully washed and cleaned by dilute acid and dried. Proper precautions and measures shall be taken to ensure that the tiles are not damaged in any way till the completion of the construction.

If any tile is disturbed or damaged it shall be refitted or replaced, properly jointed and cleaned as directed.

**16.6 Pre-Cast Chequerred Tiles 28 Mm Thick - With Marble Chips:
Dark shades using ordinary grey cement**

16.6.1 Materials

Water shall conform to M-1 Cement shall conform to M-3. Lime Mortar shall conform to M-7. Cement mortar shall conform to M-8. the precast chequerred tiles of 28 mm. thick shall be of Dark shade using white cement and conform to M-30.

16.6.2 Workmanship

The work shall be carried out as per I.S. 1443 – 1972.

16.6.3 Bedding:

Before spreading the mortar, the sub-base of the floor shall be cleaned of all dirt, scum and loose materials and then well wetted without forming any pools of water on the surface.

In case of R.C.C. floors, the top shall be left a little rough, all points of level for the finished surface shall be marked out. The lime mortar of proportion 1:1.5 (1 lime putty : 1.5 fine sand) or cement mortar 1:6 as directed shall then evenly and smoothly spread over the bed. Then after the tiles laid and jointed with neat cement slurry mixed with pigment to match the shade of the tiles as directed .Bedding layer or mortar shall be not less than 10 mm and average thickness of bedding shall be 12 mm.

16.6.4 Laying:

Before laying the terrazzo (Marble / Mosaic) tiles, the tiles shall be thoroughly wetted with water. Neat cement grout of required consistency at 4.4 kg cement / sq.mt. shall be spread on the mortar bed. The tiles shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slopes. There shall be no hollows left. The joints shall be of uniform thickness and in straight line as per the pattern.

The surface of flooring shall be checked frequently with a straight edge at – least two meters long so as to obtain a true surface with required slope.

The tiles which are fixed in the adjoining the wall shall go about 10 mm under plaster. Skirting or dedo shall be left unfinished for about 50 mm above finished floor level and unfinished strip then left earlier shall be finished.

In places where full tiles can not be fixed. The tiles shall be cut to the size and smoothened at edges to give straight and true joints.

After the tiles have been laid, the surplus cement slurry and the joints shall be cleaned and washed fairly deep before cement hardens.

The day after tiles have been laid, the joints shall be cleaned of every cement grout with a wire brush to a depth of about 5 mm and then grouted with white cement with or without pigment to match the shade of the topping of tile.

16.6.5 Curing:

The flooring shall be kept wet with damp sand or water for seven days. It shall be kept undisturbed at least for 14 days. The grinding shall normally be commenced after 14 days.

16.6.6 Polishing:

After the tiles are properly cured, first grinding shall be done with carborundum stone of 48 to 60 grade grit fitted in machine. Water shall be properly used during grinding. When the chips show up and the floor has been uniformly rubbed, it shall be cleaned with water, baring all pin holes. It shall then be covered with a thin coat of white cement mixed with or without pigments to match the color of the topping of the tiles. Pin holes if any shall thus be filled. This grout shall be kept moist for a week. Thereafter second grinding shall be started with carboundum of 120 grit. Grouting and curing shall follow again. Final grinding shall be done when other works are finished. The machine shall be fitted with carborundum of grit 220 to 350 using water in abundance. The floor shall then be washed clean with water. Oxalic acid powder shall then be dusted at 33 grams per square meter on the surface and the surface rubbed with machine fitted with hessian bobs or rubbed hard with pad of wooden rags. The floor shall then be washed clean and dried with a soft cloth or Linen. The finished floor shall not sound hollow when tapped with a mallet.

If any tiles is disturbed or damaged it shall be refitted or replaced properly jointed and polished.

16.6.7 Testing

Testing of the tiles shall be carried out by the contractor at his own cost as per IS requirement for required tests.

16.7 IPS Flooring :

16.7.1 IPS flooring shall be 40 mm thick in cement concrete 1:2:4 (1 Cement : 2 coarse sand : 4 Stone aggregate 20 mm. nominal size) with a floating coat of neat cement.

16.7.2 The cement concrete flooring of 40 mm. thick (average) is to be laid as per the site conditions. The concrete shall be mixed in a mechanical mixer at the work. Hand maxing may be allowed for smaller quantities of work and in case of failure of machineries or as permitted by the Engineer-in-charge. It shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However, in such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mechanical mixing shall be done for a period of 1.5 to 2 minutes. the quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose. Flooring of specified thickness shall be laid in accordance with the approved pattern or as directed. Finishing operation shall start shortly after the cessation or beating and shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be left for some time till mixture mixed with water to form a thick slurry and spread over the surface while the concrete is still green. Use of dry cement or cement and sand mixture sprinkled on this surface to stiffen the concrete or absorb excessive moisture shall not be permitted. The cement slurry shall then be properly pressed twice by means of iron floats, once when the slurry is applied and the second time when cement starts setting and finished floated smooth. The surface shall be marked with string or B.R.C. fabric jali to make the surface non-slippery as and when directed. The junction of floors with wall plaster, dado or skirting shall be rounded off where so required up to 25 mm. Radius flooring in lavatories and bath rooms shall be laid after fixing of water closet and squatting pans and floor traps which shall be plugged while laying the floors and opened after the floors are completed. Any damage done to the water supply or sanitary fittings during execution of work shall be made good.

16.7.3 After the final set, the concrete shall be kept continuously wet, if required by ponding for a period of not less than 7 days from the date of placement.

16.7.4 The form work shall be provided if necessary as directed by the Engineer-in-charge. Concreting shall be done as per alternate bay method with necessary centering either by mastic or cement mortar as directed.

17.0 Water Closet :

17.1 The pan shall be sunk into the floor and embedded in a cushion of average 15 cms. cement concrete 1:5:10 (1 cement; 5 fine sand; 10 graded stone aggregate or brick aggregate 40 mm. nominal size) or as specified. This concrete shall be left 115 mm. below the top level of the pan so as to allow for flooring and its bed concrete. The floor should be suitably sloped so that the waste water is drained into the pan. The pan shall be provided with 100 mm. 'P' or 'S' trap with approximately 50 mm. seal. The joints between the pan and the trap shall be made leak- proof with cement mortar 1:1 (1 cement; 1 fine sand).

17.2 The 'P' or 'S' trap shall be fixed with pan and cast iron pipe with C.M. 1:1. The pan shall be provided with a 100 mm. 'P' or 'S' trap an approximately 50 mm. seal. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1 cement; 1 fine sand).

17.3 After laying the floor, the floor shall be suitably sloped so that the waste water is drained into the pan. A pair of footrests of size 250 mm x 130 mm x 30 mm of white vitreous china shall be set in cement mortar 1:3 (1 cement; 3 coarse sand). The foot rests shall be fixed at a distance of 175 mm. from the inner edge of the back side of the pan and shall be fixed at convenient angle.

18.0 Wash Basin :

- 18.1 The wash basin shall be fixed on the wall as and where directed. The wash basin shall be supported on a pair of R.S. or C.I. brackets fixed in C.M. 1:3 (1 cement; 3 sand). The bracket shall conform to I.S. 775-1962. The wall plaster on the rear shall be cut to rest the top edge of the wash basin. After fixing the basin, plaster shall be made good and surface finished to match with the existing one.
- 18.2 The bracket shall be painted white with ready mixed paint. The C.P. brass trap and union shall be connected to 32mm.dia. waste pipe which shall be suitably bent towards the wall and which shall discharge into an open drain leading to a gully trap or direct into the gully trap on the ground floor and shall be connected to a waste pipe through a floor trap on the upper floors. C.P. brass trap and union may not be provided where the surface drain or a floor trap is placed directly under the basin and the waste is discharged into vertically.
- 18.3 The height of the front edge of the wash basin from the floor level shall be 80 cms.
- 18.4 The capstan head pillar tap of specified dia. shall be fixed as directed with required washers of selected leather or rubber asbestos composition or plastic as directed. The cock shall be fixed with pipe line with white zinc and spun yarn, to make joint water tight. The work shall be carried out in best workman like manner.
- 18.5 C.P. brass waste trap and union shall be connected to 32mm.dia. waste pipe which shall be connected suitably towards the wall and which shall discharge into the drain through a floor trap. The C.P. brass waste trap shall be provided for wash basin or sink as the case may be.
- 18.6 The stop cock shall be fixed in position by means of jam, nut & socket. The stop cock shall be fixed near the inlet of the water meter or as directed. The joints shall be done with white zinc and spun yarn. The joint shall be tested for leak proofing.
- 18.7 The necessary inlet, outlet connections and fittings such as pillar coasks, C.P. brass waste trap, waste pipe, stop cock etc. shall be fixed as specified above.

19.0 Urinal :

- 19.1 The white earthenware flat back or corner type urinal of size 430mm. x 260mm. x 350mm. shall conform to M-45.
- 19.2 The urinals shall be fixed in position by using wooden plugs and screws and shall be at a height of 65 cms. from the floor level to the top of the lip of urinal, unless otherwise directed. The wooden plug shall be 50 mm. x 50 mm. at base tapering to 38 m. x 38 mm. at top and 50mm. in length shall be fixed in wall in cement mortar 1:3 (1 cement; 3 coarse sand). The urinal shall be connected to a 32 mm. dia. galvanized mild steel waste pipe which shall discharge in the channel or after tap. The connection between the urinal and flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

20.0 C.I.Nuhni Trap (75 Mm Dia) :

- 20.1 The nahni trap with 100 mm. dia. inlet and 50 mm. dia. outlet shall be fixed as required or as directed.

- 20.2 The nalni trap shall be jointed with C.I. pipe, 75 mm. dia. with lead joints. The lead joints shall be done in conformation with I.S. 782-1976.

21.0 Gully Trap : (150 Mm X 100 Mm) :

- 21.1 The gully trap shall be set in c.c. 1: 4: 8 extending 30 cms. beyond the trap on the three sides over which shall be constructed one brick masonry chamber of suitable size with C.I. cover in top. The lid of cast iron along with C.I. frame of size 300 mm. x 300 mm. inside shall be of approved quality and fixed in c.c. 1:2:4 75 mm. thick at top. The trap shall have C.I. gratings on top.
- 21.2 The C.I. cover shall be painted with two coats of anticorrosive paint of approved make.

22.0 Sewer Trap : (100 Mm X 150 Mm) :

- 22.1 Necessary excavation shall be done as required. The foundation cement concrete of 1: 4: 8 shall be laid for a thickness of 15 cms. The S.W. trap shall be fixed into the position on the main sewer side of the chamber as directed. Brick masonry chamber of one brick thickness in C.M. 1:5 shall be constructed with the inside dimensions 60cms. x 45cms.
- 22.2 The inside of the chamber shall be plastered in 12 mm. thick C.M. 1:3 and shall be finished smooth with cement slurry.
The outside of the chamber shall be plastered to a depth of 30 cms. from the top of the chamber. The item also includes providing and laying 1: 2: 4 cement concrete for fixing the C.I. frame and cover. The C.I. frame and cover shall be of the specified size and it shall not weigh less than 50 Kg. including frame and cover.

23.0 Galvanized Mild Steel Tubes :

- 23.1 Galvanized mild steel tubes of specified dia. nominal bore shall conform to I.S. 1239-1961. The galvanized fittings, clamps, etc. required for specified dia. bore pipes shall be of best quality and make as approved by the Engineer-in-charge.
- 23.2 Cutting, Laying & Jointing - When the tubes are to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The ends of the tubes shall then be threaded conforming to the requirements of I.S. 554- 1955 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together.

The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack as the latter procedure may not result in a water tight joint. The screw threads for the tube and fittings shall be protected from edge until they are fitted.

In jointing the tubes, the inside of the socket screwed end of the tubes shall be oiled and smeared with white or red lead and wrapping around with a few turns of fine spun yarn round the screwed end of the tube. The end shall then be tightly screwed in the socket, tees, etc. with a pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joints shall be removed after screwing. After laying the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after jointing shall be painted or in the case of under ground piping thickly coated with approved anti-corrosive paint to prevent corrosion.

- 23.3 Laying in Trenches - The width and depth of the trenches for different diameters of the tubes shall be as - For 15 to 80 mm. dia. tube width of trenches shall be 30 cms. and depth of trenches 60 cms. At joints, the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications of earth work in trenches.

The pipes shall be painted with two coats of anti-corrosive bitumastic paint of approved quality. The pipe shall be laid on a layer of 75mm. sand filled up to 150mm. above the pipe if so specified. The remaining portion of trench shall be then filled with excavated earth. The surplus earth shall be disposed of as directed.

When the excavation is done in rock the bottom shall cut deep enough to permit the pipe to be laid and cushion of sand 75mm. In case of bigger diameter of tube where pressure is very high, thrust block of cement concrete 1:2:4 (1 cement; 2 coarse sand; 4 graded stone aggregate of 20 mm. nominal size) shall be constructed on all bends to transmit the hydraulic thrust without imparting the ground and spreading it over a sufficient area if so specified.

- 23.4 Fixing of Tube Fittings to wall ceiling & floors - In case of fixing of tubes and fittings to the walls or ceilings, these shall run on the surface of the wall or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern, holder clamps keeping the pipes about 15mm. clear of the wall. When it is found necessary to conceal the pipe and when specified so, chasing may be adopted or pipe fixed in ducts or recesses etc. provided that there is sufficient space to work on the pipe with usual tools. The pipe shall not ordinarily be buried to walls or solid floors, where unavoidable, pipes may be buried for short distances provided that adequate protection is given against damage and where so required joints are not buried. Where required M.S. tube sleeves shall be fixed at a place a pipe is passing through a wall or floor for expansion and contraction and other movements. In case the pipe is embedded in walls or floors, it should be painted with anti-corrosive bitumen paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime, under the floors, the pipe shall be laid in layer of sand filling.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern clamps or required size and shape, one end of which shall be properly plugged or cemented into walls with cement mortar 1:3 (1 cement; 3 coarse sand) and the other tightened round the pipes to hold it securely. These clamps shall be spaced at regular intervals in straight lengths at 2 M c/c interval in horizontal run and 2.5 M. intervals in vertical run. For pipe of 15 mm. dia. up to 25 mm. dia. the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick or concrete. However, for higher diameter pipes and holes shall be carefully made of the smallest required size. After fixing the pipe holes shall be made good with cement mortar 1:3 (1 cement; 3 coarse sand) and properly finished to match the adjacent surface.

- 23.5 Testing of Joints - After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone, and all leaking pipes removed and replaced without extra cost. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6 Kg./sq.cm. The pipe shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock and water hammer. The draw off takes and stop cock shall then be closed and specified

hydraulic pressure shall be applied gradually. The pressure gauge must be accurate. The pipes and fittings shall be tested in sections as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

24.0 R.C.C.NP3 Class Pipe As per IS:

- 24.1 Excavation of Trenches- The width of trenches shall be as required and depth shall correspond to inlet level of the pipe and to the required levels as directed. At joints, the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line, and gradient in accordance with general specifications of earth work in trenches.
- 24.2 Laying - The pipe shall be laid accurately and perfectly true to line, levels and gradients. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in a straight line without vertical or horizontal undulation. All junctions and changes in direction and diameter shall be made inside manhole by means of curved tapered channels formed in cement concrete finished smooth and benched on both sides. The body of the pipe shall rest for its entire length, on an even level bed grips being made or left on the bed to receive the sockets of the pipes.
- 24.3 Jointing - Tarred gasket or yarn soaked in neat cement slurry shall first be placed with in coupling space of each pipe and the collar shall then be placed well home over the joint of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and gasket caulked home so as to fill not more than 1/4th of the total depth of (13 mm. in depth) the collar. The remainder of the collar shall be filled with stiff mixture of cement mortar in proportion of one part of cement and one part of sharp sand. When the collar is filled, a filled shall be formed round the joints trowel, forming an angle of 45° with the barrel of the pipe. The cement mortar of (prop. 1:2) shall be mixed as necessary for immediate use. After the joint is made, any extraneous materials shall be removed from the inside of the joints with a suitable scraper or 'badger'. The newly made joints shall be protected, until set, from the sun, dry winds, rain or frost, sacking of other suitable materials which shall be used for the purpose. The mortar shall be cured for 10 days.
- 24.4 Testing of joints - The pipe line shall be tested as directed. If any leakage is visible the defective part of the work shall be made good at no extra cost. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe of joint shall be watched for and taken as indicating a defect to be made good.

25.0 Valve Chamber :

- 25.1 The size of the chamber shall be as required and as directed. Necessary excavation shall be carried out for constructing the chamber, foundation of c.c. 1:3:6 shall be 25 cm. thick and shall extend 8 cm. beyond the outer faces of the chamber. The thickness of the wall shall be as required or as directed by the Engineer depending upon the depth of the chamber.
- But in no case the thickness shall be less than 23 cm. The masonry shall be plastered by 20 mm. thick in C.M. 1:3 to a full depth inside the chamber and for a depth of up to 30 cm. below the ground level on the outside of the chamber. Providing and laying R.C.C. slab in M-200. with required reinforcement and providing and fixing manhole cover and frame in position cutting the reinforcement and placing and fixing the same in position by using binding wires as directed by the Engineer. The weight of the manhole cover frame shall be not less than 200 Kg. Necessary C.I. steps weighting not less than 5.30 Kg. shall be provided at 0.37 meter c.c. on one side of the wall. The exposed surface of the R.C.C. slab shall be plastered with C.M. 1:3.

Brick Masonry - The bricks shall be table molded good, sound, hard, square well burnt, with straight sharp edges. Their size shall be uniform. No bricks after 24 hours

immersion in water should absorb more than 20 percent of their dry weight. Any brick which in the opinion of the Engineer is defective in quality, will not be allowed to go into the work. Resistance of bricks to crushing shall not be less than 500 lbs. to the square inch. No bricks shall under any circumstances be used except such as to fulfill in all respects the conditions above specified and should the contractors fail to supply the bricks of the quality and description specified, and if such quantities as may from time to time be necessary for the expeditious progress of the work, the Engineer shall be at liberty to purchase on account of the contractor, and bring to the work such and so many bricks as the Engineer may from time to time deem necessary or desirable and the contractors shall in such case be charged with all cost which the Engineer may incur in supplying such bricks, and shall be bound to use in the work bricks so supplied.

The work shall be of best description and workmanship. No bricks shall be used in it except as closures, and in case of the contractors failing to supply good bricks, bricks approved by the Engineer only shall be used.

All bricks shall thoroughly immersed in water at least for 12 hours before being used, and the brick work shall be protected from the sun and kept well moistened for at least three days after completion. The bricks are to be evenly and truly laid, breaking joint, course by course and properly bent together in every part. The joints are to be closed and regular and in no case exceed three eighth of an inch thickness. The bond shall be English, except where otherwise specified.

All bricks masonry work shall be plastered both inside and outside. To receive cement plastering, the walls shall be prepared by racking out the joints to a depth of 1/2" and watered. The cement plastering shall consist of three parts of fine sand and one part of cement. A rendering of cement plastering of the required thickness properly gauged, shall then be applied in an even and uniform coat and shall be well and repeatedly wetted and trowelled until hard and glossy surface is obtained.

26.0 Filling With Excavated Earth :

- 26.1 The earth to be used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken.
- 26.2 As soon as the work in foundation has been completed and measured the site of foundation shall be cleared of all debris, brick bats, mortar dropping etc. and filled with earth in layers not exceeding 20 Cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The earth shall be rammed with iron rammers where feasible and with the but ends of crowbars, where rammer cannot be used.
- 26.3 The plinth shall be similarly filled with earth in layers not exceeding 20 Cms. adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finishing level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 26.4 The finished level of filling shall be kept to shape intended to be given to floor.
- 26.5 In cases of large heavy duty flooring the consolidation may be done by power rollers, where so specified. The extent of consolidation required shall also be as specified.
- 26.6 The excavated stuff of the selected type shall be allowed to be used in filling the trenches and plinth. Under no circumstances black cotton soil be used for filling the plinth.

27.0 Snowcem, Distemper, Oil Paint :

27.1 General

a] Preparation of Surface & Priming coat :

The surface shall be thoroughly brushed free from mortar dropping and other foreign matter and sand papered smooth.

A priming coat of whitening shall be applied over the prepared surface in case of water-bound distempers and distemper primer or cement primer shall be applied in the case of oil bound distemper. No white washing coat shall be used as a priming coat for distemper.

b] Application :

After the primer coat has dried for at least 48 hours, the entire surface shall be coated uniformly with proper distemper brushes in horizontal strokes, immediately followed by vertical ones which together shall constitute one coat.

c] Scaffolding -

Where scaffolding is necessary it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be white or colour washed. A properly secured strong and well tied suspended platform (zoola) may be used for white washing. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the floors and walls. For white washing of ceilings, proper stage scaffolding shall be erected where necessary.

28.2 All weather shed paint:

Finishing wall with all weather shed paint on undecorated wall surface (three coats) to give an approved brand and manufacture and of required shape even shade after thoroughly brushing the surface to remove all dirt and remains of loose powdered materials.

The surface shall be thoroughly scrapped clean, finishing walls shall be completely cleaned before applying all weather shed paint. The shed and quality must be approved by Engineer-in-charge of the work before starting the work. The all weather shed paint shall be applied with the fine brush and allowed to set before second coat is applied. The rate shall include necessary scaffolding, tools and plants and sufficient watering, curing etc. complete.

The work shall be carried out to the entire satisfaction of the Engineer-in-charge of the work and in best workmanship like manner as per specification of manufacturer and P.W.D. H.B. Vol. I & II and as directed.

28.3 Oil Paint :

All doors, windows, ventilators, shutters, railing, all fabricated items, motors, pumps, all interconnecting piping above ground level etc shall be colored with three coats of approved make oil paint strictly as directed by Engineer-in-charge.

24.4 Distempers :

1] Distempers shall be of the oil or water bound type as specified.

2] Material :

Dry distemper or oil bound washable distemper of approved brand and manufacture for water bound and oil bound respectively conforming to IS : 428 shall be used. The proportions of the mix shall be as per the approved manufacturer's instructions.

- a) The dry distemper shall be stirred slowly in clean warm water using 0.6 liter of water per kg. of distemper or as specified by the approved makers. The mixture shall be well stirred before and during use to maintain an even consistency.
- b) Thinner as stipulated by approved manufacturer shall be used in case of distemper for oil bound type.
- c) Dry distemper shall not be mixed in larger quantity than is actually required for one day's work.

28.0 Acrylic Emulsion Paint

Materials

It shall be from Nerolac, Asian Paints, ICI, Berger or equivalent, as approved by the Architect and Project Manager. It shall conform to the relevant I.S. Codes.

It shall be used on both interiors and exteriors, on all different types of plaster, wooden surfaces, stone, brickwork, asbestos cement sheets, hard and soft boards, etc. It shall render rich smooth finish and shall provide a tough film that forms a suitable protector against all elements.

It shall be water based. It shall require no primer. On a well prepared surface, it shall be applied, after one coat of cement primer, incase it is an interior surface and waterproof cement coating, incase it is an exterior surface. On a new but highly absorbant surface, a thin coat of the same shall be applied by adding two parts of water by volume to two parts of Acrylic Emulsion by volume. -On previously painted surfaces, one coat of the same shall be applied by thinning four parts of the emulsion with one or two parts of water. It shall be applied by brush, roller or spray. It shall have a covering capacity of 25-30 m²/liter, depending on the surface and shade used. It can be washed to remove the day-to-day dirt, after the surface has been painted, minimum for a month.

Execution

General

- a) The materials required for work of painting work shall be obtained directly from approved manufacturers or approved dealer and brought to the site in maker's drums, cage etc. with seal unbroken.
- b) All materials not in actual use shall be kept properly protected, lid of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. The materials which have become stale or flat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in smaller container. No left over paint shall be put back into stock tins when not in use.
- c) If for any reasons, thinning is necessary, the brand of thinner recommended by the manufacturer shall be used.
- d) The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt and grease shall be thoroughly removed before painting is started. No painting on exterior or other exposed parts of the work shall be carried out in wet, damp or otherwise unfavorable weather and all the surfaces shall be thoroughly dry before painting work is started.

- e) For Glossy, Flat, Pearl lustre and Matt finish, painting of same specification shall be followed except that the type of paint shall be changed as per the direction of Architect and Project Manager, to give the desired finish.

Scaffolding :

The relevant specifications of Para 2.3 of item No. A of this section shall be followed.

Preparation of surface :

The relevant specifications of Para 2.2 of item D of this section shall be followed.

Preparation of Mix

This shall be done as per the manufacture's instructions. The thinning of emulsion is to be done with water and not with turpentine. The quantity of thinner to be added to shall be as per manufacturer's instructions.

Application :

- a) Before pouring into small containers for use of applying, the paint shall be stirred thoroughly in its container. Also, the paint shall be continuously stirred in the smaller container, so that its consistency is kept uniform.
- b) Brushing operations are to be adjusted to the spreading capacity advised by the manufacturer of particular paint. The paint shall be laid on evenly and smoothly by means of crossing and laying off.

The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work.

- c) The paint shall be applied with brush for first two coats and final coat shall be done with roller only.

The surface shall be treated with minimum one coat of alkali resistant primer and putty as specified in relevant specification of workmanship of item D of this section. The second or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking of the brush being used.

- d) The surface on finishing shall present a flat velvety smooth/pearl luster (semi gloss) finish, as specified in the item. It shall be even and uniform in shade without patches, brush marks, paint drops etc.

Precautions :

- a) Old brushes if they are to be used with emulsions paints, shall be completely dried of turpentine or oil paint by washing in warm soap water. Brushes shall be quickly washed in water immediately after use and shall be kept immersed in water during break periods to prevent the paint from hardening on the brush.

- b) In the preparation of walls for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.
- c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
- d) Washing of surfaces treated with emulsion paint shall not be done within 3 to 4 weeks of application.

Protection Measures

The surface of doors, windows, ventilators, floors, of furniture etc. and such other parts of the building not to be white/colour washed shall be protected from being splashed upon. Such surfaces shall be cleaned of white/colour wash splashed, if any, immediately after completing the painting, at no extra cost.

29.0 GI Railing :

- 29.1 The railing shall be fabricated from G.I. (Class-B, Medium) pipes, conforming to IS . They shall consist of horizontal pipes welded at a spacing of not more than 450 mm to vertical balustrade pipes of 40 mm dia. The vertical pipes shall be spaced at 1.5 m c/c. The fabricated railing shall be installed using 6 mm thick M.S. base plate and 12 mm dia M.S. 'J' bolts. The exposed faces shall be painted with rubber paint.

30.0 MS Ladder :

- 30.1 The M.S. ladder shall be used where access to elevated tanks is essential for operation and maintenance. It shall be fabricated from M.S. angles and channel section. The span of the ladder shall be not less than 60 cms. The angles used shall not be less than ISA 40 x 40 x 6 mm. A chequered plate of thickness 6 mm shall be provided for every step. For ease in climbing the pitch of ladder shall be restricted to 60 degree. The rise of the steps shall be restricted to 25 cm. All M.S. surfaces shall be coated with epoxy to prevent the corrosion. The railing for the ladder shall be fabricated from 25 mm GI pipes.

31. Plumbing – G.I. Pipes

1. Materials

Galvanized mild steel tubes of specified dia. nominal bore shall conform to I.S. 1239-1961. The galvanized fittings, clamps, etc. required for specified dia. bore pipes shall be of best quality and make as approved by the Engineer-in-charge.

2. Workmanship

Cutting, Laying & Jointing - When the tubes are to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The ends of the tubes shall then be threaded conforming to the requirements of I.S. 554-1955 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together.

The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack as the latter procedure may not result in a water tight joint. The screw threads for the tube and fittings shall be protected from edge until they are fitted.

In jointing the tubes, the inside of the socket screwed end of the tubes shall be oiled and smeared with white or red lead and wrapping around with a few turns of fine spun yarn round the screwed end of the tube. The end shall then be tightly screwed in the socket, tees, etc. with a pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joints shall be removed after screwing. After laying the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after 3 jointing shall be painted or in the case of underground piping thickly coated with approved anti-corrosive paint to prevent corrosion.

- 3 Laying in Trenches - The width and depth of the trenches for different diameters of the tubes shall be as - For 15 to 80 mm. dia. tube width of trenches shall be 30 cms. and depth of trenches 60 cms.

At joints, the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications of earth work in trenches.

The pipes shall be painted with two coats of anti-corrosive bitumastic paint of approved quality. The pipe shall be laid on a layer of 75mm. sand filled up to 150mm. above the pipe if so specified. The remaining portion of trench shall be then filled with excavated earth. The surplus earth shall be disposed of as directed.

When the excavation is done in rock the bottom shall cut deep enough to permit the pipe to be laid and cushion of sand 75mm. In case of bigger diameter of tube where pressure is very high, thrust block of cement concrete 1:2:4 (1 cement; 2 coarse sand; 4 graded stone aggregate of 20 mm. nominal size) shall be constructed on all bends to transmit the hydraulic thrust without imparting the ground and spreading it over a sufficient area if so specified.

- 4 Fixing of Tube Fittings to wall ceiling & floors - In case of fixing of tubes and fittings to the walls or ceilings, these shall run on the surface of the wall or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern, holder clamps keeping the pipes about 15mm. clear of the wall. When it is found necessary to conceal the pipe and when specified so, chasing may be adopted or pipe fixed in ducts or recesses etc. provided that there is sufficient space to work on the pipe with usual tools. The pipe shall not ordinarily be buried to walls or solid floors, where unavoidable, pipes may be buried for short distances provided that adequate protection is given against damage and where so required joints are not buried. Where required M.S. tube sleeves shall be fixed at a place a pipe is passing through a

wall or floor for expansion and contraction and other movements. In case the pipe is embedded in walls or floors, it should be painted with anti-corrosive bitumen paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime, under the floors, the pipe shall be laid in layer of sand filling.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern clamps or required size and shape, one end of which shall be properly plugged or cemented into walls with cement mortar 1:3 (1 cement; 3 coarse sand) and the other tightened round the pipes to hold it securely. These clamps shall be spaced at regular intervals in straight lengths at 2 M c/c interval in horizontal run and 2.5 M. intervals in vertical run. For pipe of 15 mm. dia. Up to 25 mm. dia. the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick or concrete. However, for higher diameter pipes and holes shall be carefully made of the smallest required size. After fixing the pipe holes shall be made good with cement mortar 1:3 (1 cement; 3 coarse sand) and properly finished to match the adjacent surface.

- 5 Testing of Joints - After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone, and all leaking pipes removed and replaced without extra cost.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6 Kg./sq.cm. The pipe shall be slowly and carefully charged with water allowing all air to escape and avoiding all stock and water hammer. The draw off takes and stock shall then be closed and specified hydraulic pressure shall be applied gradually. The pressure gauge must be accurate. The pipes and fittings shall be tested in sections as the work of laying proceeds, weeping the joints exposed for inspection during the testing.

32.0 PVC Rain Water Pipes :

32.1 Materials:

The specified dia. PVC spigot and socket soil or waste pipe / Rain water pipe.

32.2 Workmanship:

32.2.1 The PVC spigot and socket soil or waste / rain water pipe shall be joined as following procedure. Cut the PVC pipe with a fine toothed saw to the required length pipe should be square.

Chamfer the edge of the pipe to be inserted at an angle of about 15 to about 1/3 the wall thickness, using a course file.

Make sure the spigot and socket are thoroughly clean and dry. Insert the pipe without the seal ring and mark along the pipe, when it is fully inserted. Fix the rubber ring into the groove without twisting it.

Apply jointing lubricant to the chamfered end of the pipe, mark made on spigot or to the socket end of the fitting. Push the pipe firmly into the socket till the gap between the mark on the spigot and socket is about 10 mm to allow for thermal expansion.

The pipe clips should be spaced at intervals of not more than ten times the outside diameter of the pipes for horizontal runs and for vertical lines are spaced at interval of one meter to a maximum of two meters according to pipe diameter.

All entry to main stacks should be protected with minimum 50 mm water seal traps, wherever there is a mixing of soil and waste lines. Smoke dust should be avoided and test plug or socket plug should be used for testing the lines.

All soil / Rain pipes shall be carried up above the roof and shall have a wire balloon guard or a cowl.

The ventilating pipe or shaft shall be carried out to a height of at least one meter above the outer covering of the roof of the building or a case of windows in a gable wall or a dormer windows it shall be carried up to the ridge of the windows. In case of flat roof to which access for use is provided, it shall be carried up to a height of at least two meters above the parapet or two meters measured vertically from the top of any windows or opening may be exits up to a horizontal distance of the five meters from the vent pipe in to such building and in no case shall be carried out to a height less than 3 meter.

The connection between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning.

33.0 Non-Toxic Anti-Corrosive Food Grade Epoxy Inner & Outer Coating To M.S. Pipes

- 33.1 Inner & outer surface of the pipes shall be prepared for the application of paint by first cleaning the surface with wire brush. Sand blasting shall be carried out in the presence of an authorized representative of client and as per the provisions of IS:1477 Part (I). All the mill scale and rust must be perfectly removed and inner bars metal surface of the pipe should appear neat, clean and fresh so that the paint applied afterwards should adhere it perfectly. Any trace of grease shall be removed carefully. Such clean, rough (roughness should be within 20 microns) bars metal surface will allow proper adhesion of the lining to the pipe. The Engineer-in-charge may exercise the right to examine the blast cleaned surface before application of priming coat. If the surface is rejected as not meeting the specification requirements, the contractor will be required to perform at his expense, such work as will be necessary to prepare the surface to the satisfaction of the Engineer-in-charge.
- 33.2 The compressed air used for blast cleaning shall be sufficiently free from oil or water contamination to ensure that preparation is not impaired. Adequate separators, traps and filters shall be provided which shall be cleaned and maintained regularly.
- 33.3 Inner & outer surface prepared as mentioned in (i) above shall immediately in no case beyond four hours be followed by an application of Zinc rich primer. The primer shall be applied

by spray or brush. The application of the primer shall be as per the recommendation of the manufacturer.

The technical specifications of the primer shall be as under.

A two component heavy duty prefabricated primer based on Zinc Dust and epoxy resins shall be Di-ethylene glycol of Bisphenol A and hardener shall be Adduct Hardener of Basic Liquid resin and aromatic amine. The primer shall be non-phenolic.

The preparation of paint shall be carried out as below.

Part By Weight

Base	:	100
Hardener /Hardeners	:	50

Mixed paint (Primer) shall have properties:-

- | | | | |
|-----|-------------------------------------|---|--|
| (a) | Viscosity | : | |
| (b) | Specific Gravity | : | 1.70 + 3% |
| (c) | Pot Life mixture at
30 Degree | : | 2 to 4 hours |
| (d) | Zinc dust content on
D.F.T. base | : | 92 +/- 3% |
| (e) | Finish | : | Smooth and matt. |
| (f) | Shade | : | Grey |
| (g) | Drying Time | : | Surface dry within 5 minutes
and Hard dry within 1 hour.
Over coating can be done
After 24 hours. |
| (h) | D.F.T. | : | 25-30 microns |
| (i) | Compatibility | : | Compatible with all systems
of paints like Bituminous,
conventional and epoxy Paints |
| (j) | Toxicity | : | Non toxic |
| (k) | Coverage | : | 10 Sq.mt./kg. at 25 microns |

33.4 Non-toxic anti corrosive Food Grade Epoxy paint shall match the following

- | | | | |
|----|----------|---|---------------------------|
| a) | Dry time | : | Surface dry not more than |
|----|----------|---|---------------------------|

4 hours. Hard dry not more
than 18 hours.

- b) Covering capacity : 2-2.5 Sq.mt. / Kg.
- c) Toxicity : Food Grade
- : 300 micron (100 micron per
coat).

Preparation may be carried out as under

Base	<u>Parts by weight</u>
	100
Hardener	60(45 + 15)

In order to obtain satisfactory adhesion between subsequent coats, the previous coat may be lightly abraded with fine sand paper, if it is already set hard. The paint may preferably be applied with brush.

Approximate lengths of 0.50cm at both the ends of pipe shall be left uncovered with paint application as these ends are to be sealed welded. After laying the pipe in the trench and properly completing the welding joint. Painting work left earlier should be completed in the manner stated as above.

The mode of application and materials shall conform to the following I.S. Standards.

- (a) IS:1477 : Code of practice for painting
- (b) IS:6049 : Code of practice for application of
temporary corrosion preventives.
- (c) IS:9197 : Code of practice for Epoxy resin
and Hardener.

- 33.5 Unless otherwise specified herein the concerned Indian Standards shall be followed to its latest revision or amendments.
- 33.6 In general, the requirements of IS:1477 “Code of practice for painting of Ferrous metals in buildings and allied products” (Part-I & II) and IS:6049” Code of practice for application of temporary corrosion preventives” shall be met in carrying out the painting and / or preparatory work.
- 33.7 The storage, mixing and application of paints shall strictly carried out in accordance with the paint manufacturer’s printed recommendations very strictly, this is in addition to the fulfilling the specifications of this tender. Make of the paints / primer shall be Hindustan Ciba Geigy, Cibatul, SIP resins, or its equivalent companies only.

- 33.8 The thinning of all coatings shall only be carried when absolutely necessary, and then only in accordance with the paint manufacturer's instructions.
- 33.9 The painted surface shall be allowed to dry and cure in accordance with the paint manufacturer's open pot Life period and the required drying time between coats allowed in all cases. Under no circumstances shall the "Pot Life" be extended by the addition of new paint or other media.
- 33.10 The Consultant/Engineer-in-charge reserves the right to inspect the surface prepared and painting operations at any stage and to require any unsatisfactory workmanship to be remedied at the contractor's expenses.
- 33.11 Inadequate dry film thickness shall necessitate the application of a further coat or coats of paint to provide the full minimum dry film thickness specified.
- 33.12 An elcometer or similar instrument shall be used to determine dry film thickness. On micaceous from oxide coatings and on non-magnetic substrata, a non-magnetic measuring instrument shall be used.
- 33.13 If the quality of the protective coating is impaired by excess dry film thickener showing wrinkling, cracking, or softness, the contractor shall remove the defective coating and repaint the effected area to the satisfaction of the Engineer-in-charge.
- 33.14 Pipes when painted shall not be handled, stacked, or exposed to condensation, or rain, until the last applied coat is completely dry and in the case of two pack – materials the coating has thoroughly cured.
- 33.15 The contractor shall furnish and install the necessary scaffolding, runaways etc. required to complete the work include in this specified.
- 33.16 The painting shall be carried out against welding parts of piping after it is confirmed that all tests for piping have passed.
- 33.17 All paints in a particular paint system shall be from one paint manufacturer unless agreed otherwise.
- 33.18 Damaged areas shall be cleaned down and retouched with compatible primer before over painting.
- 33.19 On surface preparation, painting shall be carried out in climatic condition which will result in inferior protection to metal surface. The paint must be applied to dry surfaces in a dust-free atmosphere. Preparation and painting shall not take place in open during rain or fog or when condensation is likely to affect the paint film before it is dry.

NOTE:-Contractor shall have to submit test certificates of anti corrosive epoxy paint and food grade quality epoxy paint from the authorized laboratory.

Safety:

- 33.20 All safety regulations and requirements in force at the job site shall be adhered to by the contractor. Prior permission to proceed with the painting shall be obtained from the Consultant/Engineer-in-charge for coating areas in which painting work will be done.
- 33.21 Any spillage of volatiles shall be wiped up immediately, oily or solvent rags and waste shall not be allowed to accumulate, anywhere within the job site and shall be kept in closed containers and in minimum quantity.
- 33.22 No painting shall be done adjacent to fire hazard, such as welding, open flame or sparkle metal fabrication. No smoking shall be allowed within the plant premises.
- 33.23 Materials shall be stored in a location approved by the Consultant / Engineer-in-charge. Storage space shall be kept clean and free from fire hazards.

Epoxy Lining Work

34.1 Materials

- 34.1.1 The epoxy resin and hardener formulation for laying of joint less lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS:9197.
- 34.1.2 The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:
 - a) Hydrochloric acid up to 30% concentration
 - b) Sodium hydroxide up to 50% concentration
 - c) Liquid temperature up to 60deg.C
 - d) Ultraviolet radiation
 - e) Alternate wetting and drying
- 34.1.3 Sand shall conform to grading zone III or IV of IS:383.
- 34.1.4 The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.
- 34.1.5 Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the CLIENT.

34.2 Workmanship

- 34.2.1 The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.
- 34.2.2 The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.
- 34.2.3 The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.
- 34.2.4 Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.
- 34.2.5 Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Troweling shall be carried out to obtain uniformly the specified thickness of lining.
- 34.2.6 Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

35.0 White washing with lime of any color mix on ceiling and wall surface (3 coats) to give an even shade including thoroughly brooming the surface to remove all dirt dust, mortar drops and other foreign materials at all floors etc. complete.

35.1.0 Materials

- 35.1.1 The clear colour shall be made from glue and boiling water. The mixture shall be suitably tinted where required for use under colored distemper if directed. Glue shall conform to I.S. 852-1969 (Specifications for animal glue).
- 35.1.2 Lime used shall be freshly burnt, class “C” lime (fat lime) and while in colour confirming to I.S. 712-1973. Water shall conform to M-1. Best quality of gum shall be used in the preparation of white wash. Ultramarine blue or indigo shall conform to I.S. 55-19770 for paints, and shall be used for preparation of white wash. Pigments, mineral colors, not affected by lime shall be used in preparing colour wash.

35.2.0 Workmanship

- 35.2.1 Preparation of white wash solution – The fat lime shall be slaked at site and shall be mixed and stirred with about five liters of water for 1 Kg. of unslaked lime 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. 4 Kg. of gum dissolved in hot water shall be added to each cubic meter of lime cream. Small quantity of ultramarine blue (up to 5 gm. Per Kg. of lime) shall also be used. The solution shall be stirred thoroughly before use.

- 35.2.2 Preparation of surface – The surface shall be thoroughly cleaned of all dust, dirt, mortar dropping and other foreign matter before white wash is to be applied.

The surface spoiled by smoke soot shall be scraped with steel wire brushes or steel scrapers or shall be rubbed with over burnt surkhi or brickbats. The surface shall be then broomed to remove all dust, dirt and shall be washed with clean water.

Oil or grease spots shall be removed by suitable chemical and smooth surface shall be rubbed with wire brushes.

All unsound portion of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the masonry joints properly. Such portion shall be wetted and allowed to dry. They shall then be given one coat of white wash.

All unnecessary nails shall be removed, the holes, cracks, patches etc. shall be made good with materials similar in composition to the surface to be prepared.

- 35.2.3 Scaffolding – Where scaffolding is necessary it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be white or colour washed. A properly secured strong and well tied suspended platform (zoola) may be used for white washing. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the floors and walls. For white washing of ceilings, proper stage scaffolding shall be erected where necessary.

- 35.2.4 Application of White / Colour Wash – On the surface so prepared the white wash shall be applied with “Moon” brush. The first stroke of the brush shall be from top downwards, another from bottom upwards over the first stroke and similarly one stroke from the right another from the left, over the first stroke brush before it dries. This will form one coat. Each coat shall be allowed to dry before the next coat is applied. The number of coats as specified in item shall be applied. It shall present a smooth and uniform finish free from brush marks and it should not come off easily when rubbed with fingers.

Splashing and dropping, if any, on the doors and windows, ventilators etc. shall be removed and the surface cleaned.

Priming and alkali resistant treatments, scrapping of surface, washing etc. surface spoiled by smoke & soot, removing of oil and grease spots treatment for infection with efflorescence moulds, moss, fungi, algae and lichen and patch repairs to plaster wherever done shall not be paid extra.

36. Waterproofing of Roof slab and Terraces

36.1 Providing & Laying integral cement based water proofing treatment including preparation of surface as required for treatment of roofs, terraces using brick bats for giving proper slope etc comp. as directed, consisting of following operations.

- Applying and grouting a slurry coat of neat cement using 2.75 Kg./Sqm of cement admixed with proprietary water proofing compound conforming to IS:2645 over the RCC slab including cleaning the surface before treatment.
- Laying cement concrete using broken bricks/brick bats 25 mm to 100 mm size with 50% of cement mortar 1:5 (1 cement : 5 coarse sand) admixed with proprietary water proofing compound conforming to IS:2645 over 20 mm thick layer of cement mortar of mix 1:5 (1 cement : 5 coarse sand) admixed with proprietary water proofing compound conforming to IS:2645 to required slope and treating similarly the adjoining walls up to 300 mm height including rounding of junctions of walls and slabs.
- After two days of proper curing, applying a second coat of cement slurry admixed with propriety water proofing compound conforming to IS: 2645.
- Finishing the surface with 20 mm thick joint less cement mortar of mix 1:4 (1 cement : 4 coarse sand) admixed with proprietary water proofing compound conforming to IS:2645 and finally finishing the surface with trowel with neat cement slurry and making of (300 x 300) mm square.
- The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be down in order and as directed and specified by the Engineer-in-charge.
- With average thickness of 120 mm and minimum thickness at khurra as 65 mm. (cement consumption 0.642 Bags / S.M.).

37 Rubber Paints

37.1 General

37.1.1 These paints are Chemical Resistant Paints.

The more highly corrosion resistant paints can be divided into main groups as under

- One pack paints (ready for use)
- Two pack paints (to be mixed before use)

The two pack paints shall be mixed together immediately before use since they are workable thereafter only for a restricted period of time and dry up as a result of a reaction between their components and yield hard tough films with resistance to abrasion.

37.1.2 Vinyl paints

These are based on polyvinyl resins such as polyvinyl-chloride (PVC) and polyvinyl-acetate, etc. Certain types of vinyl resin paints yield thick, relatively soft and rubber like coatings with good chemical resistance. They can be repainted without difficulty.

37.1.3 Chlorinated Rubber Paints

These paints also have good chemical resistance. The main fields of applications shall be in aggressive environments e.g. near the coast. It will provide long term protection in non-coastal situations, It is also suitable for aggressive interior situation such as Industrial area.

38. Quality of paint :

38.1 The paints which have been tested for the following qualities as per specifications given in the relevant IS Codes shall only be used.

- a) Weight test (weight per 10 Liter of paint thoroughly mixed)
- b) Drying time
- c) Flexibility and Adhesion
- d) Consistency
- e) Dry thickness and rate of consumption

38.2 Application

38.2.1 Unless otherwise specified, all metal work shall be given approved shop coats as well as field coats of painting. The item of work shall include preparation of metal surfaces, application of protective covering and drying of the paint coatings and supply of all tools, scaffolding, labour and material necessary

Coating shall be applied only to dry surfaces and the coated surfaces shall not be exposed to rain of frost before they are dry.

Unless other wise specified all painting and protective coating work shall be done in accordance with IS:1477 (Part 1).

38.3 Surface Preparation:

38.3.1 Steel surface to be painted either at the fabricating shop or at the site of work shall be prepared in a through manner with a view to ensuring complete removal of mill scale by wet grit/ sand blasting as approved and directed by the Engineer-In-Charge.

Primary coat shall be applied as soon as practicable after blast cleaning.

All slag from welds shall be removed before painting. Surface shall be maintained dry and free from dirt and oil. Work out of doors in frosty or humid weather shall be avoided.

Coatings

Prime coat to be used shall conform to the Specification of primers approved by the Engineer. Metal coating shall be regarded as priming coatings. Primer shall be applied to the blast cleaned surface before any deterioration of the surface is visible. In any case, the surface shall receive one coat of primer within 4 hours of abrasive blast cleaning.

All coats shall be compatible with each other. When metal coatings are used, the undercoat shall be compatible with the metal concerned. The undercoat and finishing coat shall

preferably be from the same manufacturer. Successive coats of different shades or colors and each shall be allowed to dry thoroughly before the next is applied. Particular care shall be taken with the priming and painting of edges, corners, welds and rivets.

38.4 Painting in the Shop

All fabricated steel shall be painted in the shops after inspection and acceptance with at least one priming coat, unless the exposed surface are subsequently to be cleaned at site or are metal coated. No primer shall be applied to galvanized surfaces.

Shop contact surfaces, if specifically required to be painted, shall be brought together while the paint is still wet.

Field contact surfaces and surfaces to be in contact with cement shall be painted with primer only. No paint shall be applied within 50 mm of designed location of field welds. Paint shall be completely dried before loading and transporting to site.

Surfaces not in contact but inaccessible after shop assembly shall receive the fully specified protective treatment before assembly.

Where surfaces are to be welded, the steel shall not be painted or metal coated within a suitable distance from any edges to be welded if the specified paint or metal coating would be harmful to welders or is expected to impair the quality of site welds.

Exposed machined surfaces shall be adequately protected.

38.5 Painting at Site

Surfaces which will be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

Surface which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.

Damaged or deteriorated paint surfaces shall be first made good with the same type of coat as the shop coat.

Where steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds, bolts and site rivets.

38.6 Methods of application

The methods of application of all paint coatings shall be in accordance with the manufacturer's written recommendation and shall be as approved by the Engineer. Spray painting may be permitted provided it will not cause inconvenience to the public and is appropriate to the type of structure being coated. Areas hard to gain access to for painting and areas shaded for spray application shall be coated by brushing.

The primer, intermediate and finishing coats shall be applied so as to provide smooth coatings of uniform thickness. Wrinkled or blistered coatings or coatings with pinholes, sags, lumps or other blemishes shall not be accepted. Where the Engineer so directs, the coating shall be removed by abrasive blast cleaning and replaced at the Contractor's expense.

Two coats of metallic lead pigmented chlorinated rubber primer shall be applied on the blast cleaned surface as per the above directives. Then after one under coat of high build

chlorinated rubber paint and lastly one finishing coat of chlorinated rubber shall be applied. Total dry film thickness shall be 200 μ m. The application method for all the coats shall be as approved by the Engineer-in-Charge. Every successive coats shall only be applied after the previous coat is sufficiently dried.

Signature & Seal of Contractor

Address

Date

8.0 Mechanical Specifications:

DETAILED SPECIFICATIONS FOR MECHANICAL ITEMS

TWIN LOBE AIR BLOWERS (ROOTS TYPE)

Air blower shall be designed to perform satisfactorily under specified start up condition, part load / full load operation, max. differential pressure operation and relief valve setting pressure and up to trip speed. All the compressor casing shall be air cooled type for up to 5500mmWC discharge pressure / water cooled type or with after cooler for more than 5500mm WC discharge pressure unless specified otherwise elsewhere in tender.

The design parameters to be considered are as under:

	Blower Design Parameters:	
a	Min. / Max. air inlet Temperature	5 / 45 Degree C
b	Design RH	65%
c	Altitude	As per Site Location
d	Capacity (Nm ³ /hr) – at Discharge	As per design / process requirement, Nm ³ /hr (defined @ 0 degree C, 1.013 bar & 0 % Rh)
e	Head / Disch. Pr. (Kg/cm ²)	As per design
f	Speed of blower	1200 RPM (max.)

Air blower shall consist of the following accessories:

- Twin lobe compressor

- TEFC Squirrel cage induction motor as per electrical specifications & of approved make. Motor for VFD operated blower shall be of VFD duty.
- Suction Filter
- Suction / discharge silencer
- V belt & V belt guard
- Motor pulley & compressor pulley
- Slide rail
- Common base frame
- Safety valve
- Anti-vibration pads
- Pressure gauges – Bourdon type, 150mm dia., SS casing, glycerin filled with manifold valve, syphon and snubber, etc. & of make as per specification for instrumentation work.
- The blower noise level shall be within 85 dB (A) at a distance of 1.86m. If noise level exceeds without hood then acoustic hood shall be provided to meet this requirement.
- Acoustic hood comprising of fabricated 50 /mm square welded tube /100 mm thickness as inbuilt wall (as per manufacturing Std) , frame, acoustic insulation of glass wool of density 30 kg3/m2 and perforated sheet on inside face and MS sheet on outside face in welded construction – as per requirement to limit noise level within limit as specified.
- Inter connecting piping comprising of discharge butterfly valve, flap/ Wafer type non-return valve, and metallic expansion bellow. Bidder to refer specification for mechanical work for rest specifications and make of valves and bellows. Additionally, the MOC of bellows and valves / internals shall be suitable to withstand the temperature at discharge of blower considering the temperature rise at delivery of blower over design ambient of 50 degC.
- Any other required accessories and protections for satisfactory running of blowers.

Material of construction of various part of the air blower shall be as under:

Casing	:	CI-FG-260, IS:210
Lobes	:	SG Iron 500/7 IS 1865
Shaft	:	En 19 /EN 24 BS:970 Part-1
Gears	:	EN-353 case hardened and ground
Common Base Frame	:	MS Fabricated

Clariflocculator

There will be one no. circular RCC clariflocculator which shall have a central area for flocculation with flocculators and outer area for clarification settling. They will have a peripheral weir with vertically adjustable 8 mm thk. FRP V notch weir plates for uniform surface withdrawal of clarified water. The weir plates shall be fixed with stainless steel anchors, nuts and washers. The flocculation zone and settling zone shall be separated by circular isolation RCC wall. All inlets, outlets passages of water shall be designed and arranged for a steady and uniform flow without undue turbulence to avoid disintegration.

A bridge with peripheral on-board drive with steel wheels traveling on the steel billets on the peripheral wall will be provided with:

- Central platform for the installation of the stirrers and their drives and for the local control panel;
- Paddle stirrers / agitators for slow mixing of the incoming raw water in the central unit;
- A radial scraper system with bottom scraper blades, suspended on the bridge.

The hydraulic equipment is:

- The inlet pipe from the flash mixer feeding into the central flocculation part;
- Sludge outlet pipe with pneumatically operated valve for intermittent operation according to an adjustable timer;
- The drain pipe with manually operated gate valve for the complete draining of the clarifier shall be provided.
- Sludge pipe from clariflocculator to dirty water sump.
- A constant bleeding arrangement for de-sludging pipe shall be provided to enable observation of the sludge quality.
- A discharge pipe/channel from the peripheral collecting channel to the main channel leading to filters.

The electrical equipment is:

- Incoming cable with slip ring contacts for the on-board power supply and the supply of all motors;
- On-board panel for all operations of the unit with connections to the main control room for indication of the status of the unit components;
- Adjustable drives for the flocculator stirrers;
- Adjustable drive for the bridges;
- Emergency stop buttons at the centre and at the outer side of the bridge;
- Lighting.

The access to the bridge is possible from the peripheral walkway of width not less than 1200 mm with a railing.

Rotating Scraper Bridge and Accessories

The bridge in welded steel construction shall span half the tank diameter and further beyond center in the direction of the walkway. The truss bridge is 1.2 M wide with walkway of MS grating. The

bridge is pivoted at the center on a slewing ring bearing and is attached to a trolley with PU sleeved wheels resting on the peripheral wall of the clarifier or alternatively steel wheels running on steel rails located along the periphery of the clariflocculator. A drive assembly located on the trolley and coupled to the trolley drive wheel through chain & sprocket arrangement rotates the bridge about the center of the clariflocculator.

The scrapper and rotating bridge shall be of MS construction. Shaft and impeller blades of flocculator shall be of MSEP material. Handrails shall be of GI material of 40 mm. pipe size medium grade.

Rotating Bridge Structure

The rotating bridge structure shall incorporate a walkway having a minimum effective width of 1200 mm which shall be surfaced with M.S, chequered plates, painted black. The bridge shall be designed to take its own dead weight together with uniformly distributed loading of 250 kg/cm² over the full span and width of the walkway bridge and a moving point load of 500 kg. Maximum deflection of the bridge under the specified loading shall not exceed 1/360th of the span. The positive camber shall be kept initially to compensate for the maximum deflection under dead weight and superimposed loads.

The bridge shall be so braced as to limit lateral deflection to less than 80 mm measured at mid span under a full load condition.

The central part of the bridge shall be large enough for the installation of the flocculator systems and the control panel.

The bridge shall have hand railing to both sides forming an enclosure at the centre in between. The finished height of the railing shall be 1.0 m above the walkway. Toe guards shall be provided and secured around the bridge walkway which shall not be less than 100 mm high and 5 mm thick.

Bridge Support and End Carriage

The bridge structure shall be supported at the centre of the clariflocculator by means of cast iron bearing assembly of the slewing ring type and incorporating trunnion type mounting to accommodate vertical undulations of the traction wheels at the peripheral wall of the tank. The central bearing assembly shall be adequately lubricated and all grease points shall be extended to a battery plate mounted at the convenient point above the walkway. Oil fill and drain points, where applicable shall be extended to provide a convenient access for filling and draining the system. Catch drains shall be provided under all oil and grease point to prevent spillage from reaching the water surface.

The wheel carriage assembly shall be suitably proportioned to provide adequate stability to the rotating bridge structure, whilst providing the suitable base for the motors, gear box, driving and idling wheels, shafts and bearings. The wheels shall be such that a de-railing cannot occur due to some misalignment. The size and design of wheels and carriage shall be calculated to transmit optimum tractive effort relative to the proportions of the scrapper without producing wheel spin when the wheel path is subject to the climatic conditions.

Both the drive and idling unit shall be fitted with suitable diameter PU sleeved wheels / steel wheels and shall be carried on the respective shafts supported on anti-friction bearings. The wheels shall travel on the clariflocculator wall.

The mechanism shall be driven by adequate HP motor mounted on the periphery of the bridge. The mechanism shall complete one revolution in 30 to 40 minutes.

Drive

The bridge drive shall comprise of either (a) motor with reduction gear, a chain sprocket or (b) a geared motor. The assembly shall be rigidly mounted and shall be adequately rated for continuous service in water treatment works environment.

All lubrication points, all necessary provisions shall be made for routine maintenance and for prevention of oil and grease spillage. A deflector shall be provided and fitted to the leading edge of the driving carriage. It shall be angled at 45° and arranged to be adjustable within 3 mm of the perimeter rail such that material coming in the way of free passage of the wheel shall be deflected.

Blades and Fixtures

Scrapers shall be suspended and arranged to give continuous and progressive scrapping of the entire floor of the clariflocculator and the swept area of the successive blades shall overlap. The scraper blades shall be manufactured from MS fitted with renewable rubber squeegees and attached to steel arms suspended from the bridge. The configuration of blades shall be designed to carry sludge and deposited suspended solids from the periphery of the tank and deposit it efficiently in the withdrawal hopper / sludge pocket.

The number and length of individual blades shall be designed by the Contractor, but the depth shall not be less than 300 mm and the thickness not less than 6 mm. Renewable fabric reinforced rubber wearing strips of cross section not less than 12 mm x 100 mm shall be fitted to each blade to provide

a continuous contact surface which is adjustable for wear. The material shall have hardness not greater than 40 and be manufactured from well-proven compound.

Backing strips shall be fitted to give support to the fixing of the rubber wearing strips and the assembly shall be secured by means of stainless-steel bolts. Appropriate washers shall be fitted beneath all bolts head and nuts.

Flocculation zone

The flocculation compartment shall be of RCC construction concentric to RCC clariflocculator tank.

Four (4) nos flocculation paddles shall be suspended from the bridge, one on each side of the center pier in the direction of bridge and one each in direction perpendicular to the bridge. The area of paddles shall be 10 – 15% of the cross sectional area of the flocculation zone. These shall be supported from the rotating bridge. The material of construction and motor HP shall be as per specification.

Motors, starters and control

The electrical supply to bridge or flocculator driving motors shall be taken through a multi ring and slip – ring collector unit mounted in a fully water proof enclosure. The unit shall be fitted at the centre of rotation of each bridge and shall be complete with all necessary support bracket, anti – rotation device. A suitable means of lubrication shall be provided.

The slip ring assembly shall be mounted above the top level of the tank walls. Sufficient rings shall be included to cover the motor supply and any ancillary circuits. Bridge drive and flocculator motors shall be of squirrel cage type, protected and shall be rated 25% above design duty and shall meet the specifications of motor mentioned under electrical section. Similarly variable frequency (adjustable) drives for paddle and bridge drive shall meet the specifications of VFD mentioned in electrical section. Overload torque control mechanism included.

All cables shall be connected to a termination box at the wall of the clariflocculator. From there, cables are connected to the main control panel. Overload torque alarm and trip signals shall be fed to PLC for suitable alarm and tripping of the drives.

The bridge drive and the flocculators shall be controlled from an outdoor panel installed in the central part of the bridge. The drive status indicating lamps shall be provided on the main control panel.

Clarified Water Collection

The collection of clarified water shall be in a peripheral launder constructed outside the tank wall. The launder shall receive clarified water through 90° degree, 8 mm thk FRP V notches of adjustable weir place fitted along the tank perimeter.

Clarifier De-sludging

The sludge shall be discharged at least once in 120 minutes or as per design through pneumatically / electric actuator operated knife gate valves with manual over ride. In addition there shall be a continuous bleed arrangement with telescopic trumpet, placed near the outlet launder and discharging into the wet pit.

The valve chamber shall be dry and wet pit type with an operation platform above. The discharges shall be let into a sludge pumping and disposal plant by gravity through pipes, for ultimate disposal into the drainage system. Suitable flushing arrangement shall be provided.

Painting

All MS parts shall be painted with Food grade epoxy paint to a total DFT of 250 microns

Testing:

Performance test	YES to be witnessed
All site testing	YES to be witnessed

Drawings:

- The manufacturer shall submit the following drawings.

- Preliminary outline dimensional drawings
- Typical cross sectional drawing showing constructional details with the complete bill of material and relevant standards.

3.0 AGITATORS / MIXERS (FOR ALUM / PE SOLUTION, CHEMICAL DOSING TANK MIXER, ETC.)

The Agitator / Mechanical Mixing Device shall comprise of rapidly rotating blades mounted on a vertical shaft coupled to the gear box shaft through rigid coupling and driven through a suitably rated 1500 RPM continuous duty electric motor TEFC with IP 55 protection operating through a reduction gear box to ensure uniform dispersal of the chemical solution / keep the sludge in suspension.

General Specification

- Agitator component shall be designed to fit through agitator opening on tank manhole.
- Pressure containing part shall have minimum corrosion allowance of 3 mm.
- Gear unit
 - A worm or suitable type of reduction gear shall be provided with a minimum service factor of 1.5 on the driver rated KW.
 - V belt operation is not acceptable.
- Flexible coupling shall be selected with a minimum service factor of 2 and shall be capable of continuous operation at the max. anticipated misalignment.
- Rigid coupling shall have tapered bores with key in nut arrangement. All rigid coupling shall be made from cast steel as per IS 1030 grade 2 or forged steel as per IS 2004 CI 3 or CI as per IS 1030 Gr 30
- Shaft sleeve with hardened surface shall be provided at standby barring and in packing areas.
- The shaft shall be suitable for transmitting full torque available for the rated driver. (Starting torque).
- Shaft shall be suitable for jamming conditions considering that rotor / impeller is jammed at 0.75 R from centre (R = Radius of impeller).
- Shaft assembly designed with critical speed at least 30% removed from any operating speed.

- Impeller blade shall be in one piece construction.
- Bearing housing shall be designed with a span suitable for the minimum radial cum thrust loading used for the design of the shaft. Life of bearing should have L10 of 25000 hr (minimum)
- It is preferred that the design of the agitator does not incorporate the use of a steady bearing at the shaft end. However if the use of such bearing is imperative the design shall be such that the bearing is of self-aligning type and pre- lubricated.
- Mounting Stool and Support Steel Structure (epoxy painted) for agitator and to suit tank size.

Mechanical Data:

Agitator type	:	Axial pitched turbine / low speed
No. of Blades	:	As per design
Impeller dia., mm	:	As per design
Gear box	:	Worm/worm wheel oil bath type vertical, single reduction
Agitator RPM	:	60-100
Shaft suspension Length	:	Suitable to Dosing Tanks Size / Depth.

Material of construction as min. as under or higher as indicated in process data sheet:

Agitator	:	SS 304
Impeller / Blade	:	SS 304
Shaft (up to Gear Box	:	SS 304
All fasteners / hardware	:	SS 304 or better

NOTE: MOC of agitator shall be suitable / better for type of fluid and as suggested by the manufacturer.

DOSING PUMPS-RECIPROCATING TYPE

GENERAL:

Dosing pumps shall be mounted in a bund separate from the storage tanks and shall be fully accessible for operating and maintenance purposes without personnel having to enter the bund

itself. Where appropriate, the pump bund shall be interconnected with the tank bund at an intermediate level.

The pumps shall be of the reciprocating mechanically actuated diaphragm type driven by electric motors. The pump, motor and drive arrangement shall be mounted on a robust combination base plate. Unless otherwise specified, only one liquid end shall be driven by any motor.

All chemical dosing pumps shall be provided with pulsation dampeners in SS-304 MOC. Metering/Dosing pumps shall have bypass with valves and external pressure safety valves.

Pumps shall comply with API standard 675, positive Displacement Pumps-controlled Volume.

The chemical dosing pumps shall be with suitable type of auto stroke adjustment facility for monitoring and controlling the dosing rate through PLC/SCADA system and closed loop control as applicable for optimizing chemical dosing and process control as specified elsewhere for each application. These pumps shall be part of an automatic coagulation control / other process control loop.

PUMP HEAD MATERIALS:

Pump heads and diaphragms shall be manufactured from thermoplastic materials suitable for the duty conditions.

PUMP STROKE ADJUSTMENT:

Variable stroke mechanisms shall be incorporated in the drive arrangement to allow infinitely variable adjustment of pump output by means of a micrometer, hand wheel or similar mechanical device whilst the pump is running.

Where the pump is part of an automatic coagulation control or other process control loop, the stroke mechanism shall be fitted with a three phase bi-directional motor with torque limiter and automatic stops at both extremes of travel. A position feedback potentiometer shall be provided to facilitate control and remote indication of position. The operational range of stroke adjustment shall be not less than 6:1.

DRIVE ARRANGEMENT:

The pump head shall be driven through a totally enclosed speed reduction gearbox with integral reciprocating drive or the adjustable crank or mechanical lost motion type. The gearbox and

reciprocating drive shall be oil bath lubricated. The unit shall incorporate filling and drain plugs for oil and an oil level indicator.

DRIVE MOTOR:

Drive motors shall be of the three phase cage induction type whether for fixed speed or variable speed operation.

Where variable speed operation is specified, the speed turn-down ratio shall be not less than 5:1.

PUMP PERFORMANCE:

The performance characteristics of the dosing pumps shall be adequate in terms of linearity, accuracy and reproducibility as designed in API standard 675 to achieve the stated plant performance guarantee. The deviation from flow linearity of the pump shall not exceed $\pm 3\%$ of the rated capacity. The steady state accuracy shall not exceed $\pm 1\%$ of the mean delivered flow under fixed system conditions over the entire turndown range. The flow rate repeatability expressed as a percent of the rated capacity of the pump shall not exceed $\pm 3\%$ of the rated capacity.

NOTE: For very capacity dosing pumps (less than or equal to 0.55KW motor rating) the bidder can consider to provide skid mounted electronic dosing pumps instead of above specified type and of MOC suitable to fluid type.

SUBMERSIBLE NON-CLOG SEWAGE PUMP (SEWAGE / SLUDGE / WASTE WATER ETC. APPLICATION)

A. GENERAL

The Pump shall be submersible, non-clog, single stage, centrifugal, wear resistance with vertical shaft suitable for permanent installation in wet-pit / sump along with Submersible motor and submersible cable of specified length. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump shall be designed to pump sewage / waste water or sludge or such fluids having impurities / solids and operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have

continuously rising head characteristics with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15 % of BEP flow on either side meeting NPSH requirement. **Pump selected with duty point lying on right side of BEP beyond 15 % limit shall not be accepted.**

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. **The pump selected for rated performance below minimum Impeller diameter shall not be accepted.**

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation's or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The pump shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts & assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 6.3 mm/sec. Noise level shall be limited to 85 dBA at a distance of 1.0 m.

The Sole plates / auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended / approved size.

The power rating of motor to drive pump shall be suitable to meet max. requirement of power for the rated impeller throughout its' performance range and specific gravity of the liquid.

B. FEATURES OF CONSTRUCTION

PUMP

Pump shall be Vertical Submersible centrifugal, single stage, Non Clog suitable for permanent installation in wet-pit / sump. The pump shall have bottom suction and side discharge nozzle. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump having delivery size upto 100 mm shall be designed to handle solids of min. 35-40 mm (for 50mm delivery size) to 80 mm size (for 100mm delivery size) such that the solid handling is one pipe size lower than offered pump delivery size. For pumps having delivery size above 100 mm. shall be capable of handling solids of minimum 100 mm size.

CASING

Pump casing shall be volute type of robust construction and designed for high efficiency. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing can be provided with wearing rings / wear plates.

Casing shall have facility for removal of clogged material from impeller vanes without dismantling the whole pump.

IMPELLER

Impeller shall be semi-open or suitable as per manufacturer's design, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two / three vanes max. and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Typical sewage has high content of sand, silt & ash. Hence the pump design shall be of wear resistant type.

Impeller shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration. The Impeller shall have back vanes or suitable features to balance axial thrust.

Pump having semi open impeller shall be provided with suitable wear plate fixed in casing with adjusting bolts & nuts.

Suitable mechanisms should be provided to avoid accumulation of grit / silt for enhanced life of mechanical seal.

IMPELLER NUT

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

SHAFT SEAL / MECHANICAL SEALS

Double mechanical seals shall be provided to protect the motor from ingress of water along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with an electrical

Tender for Up-gradation of 10 MLD out of existing
18.5 MLD CETP

monitoring system for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

BEARINGS

Pump set shall have double anti friction grease lubricated bearings. The bearings life shall be minimum 40,000 hrs of operation. Bearings shall be greased for life –i.e. shall not require any re-greasing. Bearings shall be of SKF / FAG / NBC make only.

AUTO COUPLING / GUIDE PIPE / LIFTING CHAIN

Each pump shall be supplied with pump connector unit in order to connect connector unit to pump support bracket with rubber diaphragm to make leak proof joint and fixing it to the concrete floor of the suction well. The design of the automatic coupling system shall be such that the joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails / wire rope from access level. The pedestal of the automatic coupling system shall be integrally cast with the delivery bend thereby obviating the need of separately bolted CI Duck Foot Bend. It shall be provided with all necessary fixtures like guide wire / guide pipe for guiding the pumps during lifting/lowering.

Each pump shall be provided with a stainless steel lifting chain in conforming to relevant standards. The lifting chain shall be provided with dual ‘O’ Rings / shackles in SS-304 at every about 1.5m C-C for intermediate level support of pump and changeover of hoist hook during lowering and lifting

Each pump shall be provided with a stainless steel guide pipe / wire rope of required length.

LIFTING HOOK

To “fish out” a vertical submerged pump set from the wet well (even if a chain has not been attached to the lifting hook prior to the pump set being lowered) the pump shall have a self-centering lifting hook. Its design shall be such that the lifting chain’s hook can be engaged to the pump’s lifting hook without the need for man to enter the wet well.

INDUCTION MOTOR (Submersible)

The submersible motor shall be Induction, Squirrel Cage, and Dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage : 415 Volts, 3 Phase, 50 Hz AC supply

Voltage variation	:	$\pm 10\%$
Frequency variation	:	$\pm 5\%$
Combined variation of Voltage & Frequency :		$\pm 10\%$

The Motor shall be generally designed to have performance characteristics like Nominal efficiency, Locked rotor current, etc. in line with IS: 12615:2018. (Efficiency minimum IE2 of IS: 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be min. 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump / sub. pump / driven equipment should be selected as per table of safety factor provided for Squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage & star-delta starting. Motor shall be capable of starting and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS 8783-1978 for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS 4800 (part-VII): 1970 for dry type motors. The corresponding Class of insulation shall be Class F with temperature rise limited to Class B. However, however for motors to be operated on VFD's , only Class "H" insulation with temperature rise limited to Class F is allowed and motor shall be inverter duty type and to suit for speed variation from 50% to 100% or higher..

As the cable resistance method, due care is taken to account for the correct hot and cold resistance of windings.

If these pump's motors are to be used with Variable Speed Frequency drives (VFD's) than:

- ❖ The motor insulation shall be Vacuum Varnish Impregnated instead of Dip Varnishing or Trickle Varnishing with double insulation coating.
- ❖ The motor insulation is to be of Class "H" only
- ❖ Current insulated bearing/s (preferably NDE) required for motor ratings above 200kW.

Terminal chamber shall be of IP 68 type construction to eliminate entry of storm water and dust. The Terminal chamber should be isolated from the motor chamber to prevent entry of liquid / moisture in the motor chamber through the terminal chamber. The terminal shall be the stud type with necessary plain washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

PROTECTION

Protection against increase in stator winding temperature (15 Deg. C) shall be provided. Minimum three number thermostats / bimetallic switches in series shall be provided to sense the stator winding temperature.

Sensors are to be provided to detect if leakage of water into the oil housing is above 30% concentration. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The required control unit to process these safety signals & with potential free contact o/p for alarm / trip shall be provided by pump vendor for suitable interlocking in starter circuit and /or PLC.

Manufacturer shall provide Pump Monitoring Unit (PMU) with each pump set.

SUBMERSIBLE CABLE

A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables. The cable shall be of sufficient length and shall be brought out of the submerged motor without joint to terminate in junction box / control panel, located in LT panel room /outside the wet well.

Power as well as Control Cables shall be of Dual Sheathed EPRS / PVC Armored type with required no. of Copper Core, round type and of required size as per design requirement.

The power cable shall be PVC insulated and PVC sheathed, flexible, 3.5/4.0 core round type. The size of the conductor shall be adequate for continuous use under water and air. Cable half/full core

as per design to be used for earthing. The size of the conductor and length of cable shall be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

The control cable shall be PVC insulated PVC sheathed, flexible, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor, Bearing temperature sensor, level sensor (Thermostats/ bimetallic switches/RTD) of 1.5/2.5 sq.mm, multi strand copper conductor of required number shall be provided or as required as per design. Control cable shall be with minimum 1 no. spare core.

The cable connection to the motor entry should be such that cable fitment should be possible at the site.

Earthing of the motors shall be done in accordance with the relevant provisions of IS:3043-1966 for the purpose of earthing these motors, earthing connection may be made to discharge pipe.

MOTOR COOLING

The motor cooling shall be normally by surrounding water. However jacket cooling with in-built overflow or such suitable design of other method of jacket cooling shall be provide as specified in process data sheet / scope of work or if specified in BOQ.

C. MATERIAL OF CONSTRUCTION

The specific requirement shall be considered as under:

Pump Casing	CI IS210 Gr FG 260
Casing wear ring/wear plate	CI IS210 Gr FG 260
Suc. cover/Oil chamber/ Mot. casing	CI IS210 Gr FG 260
Shaft	AISI 410
Shaft sleeve	AISI 316 (if applicable)
Impeller / Impeller Nut	CF8M
Auto Coupling Unit	CI / WCB
Hardware (Nuts, Bolts, Fasteners, etc.)	SS-304
Motor Jacket (if applicable)	SS 304
Guide rail pipe	Heavy duty min. 50 mm dia. of SS 304 of suitable length
Lifting Chain	SS-304, Min. equivalent to sump depth + 3 m with dual

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'O' Rings/ shackles at every about 1.5m C-C.

Bolts, Nuts, Fasteners, etc. SS 304 (All, Wetted & Non-wetted)

Cable length (each run) Min. equivalent to sump depth + 10 m,
whichever is higher

Max. Permissible solid Size As specified above in pump specifications

The above MOC is min. requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

6.0 SUBMERSIBLE CENTRIFUGAL PUMP (WATER / TREATED SEWAGE / CLEAR LIQUID APPLICATION)

A. GENERAL

Pump shall be Submersible, Vertical shaft, centrifugal, single stage suitable for permanent installation in wet-pit / sump /jack-well constructed on the river / dam etc. along with Submersible motor and submersible cable of specified length. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump-motor set shall be designed to pump raw / clear water and operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15 % of BEP flow on either side meeting NPSH requirement. **Pump selected with duty point lying on right side of BEP beyond 15 % limit shall not be accepted.**

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. **The pump selected for rated performance below minimum Impeller diameter shall not be accepted.**

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation's or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The pump shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts & assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 6.3 mm/sec. Noise level shall be limited to 85 dBA at a distance of 1.0 m

The Sole plates / auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended / approved size.

The power rating of motor to drive pump shall be suitable to meet max. requirement of power for the rated impeller throughout its' performance range and specific gravity of the liquid.

B. FEATURES OF CONSTRUCTION

PUMP

Pump shall be Submersible centrifugal, Vertical shaft, single stage suitable for permanent installation in clear water reservoir / sump or in wet-pit / sump / jack-well constructed in the river /sump/ dam etc. The pump shall have bottom suction and side discharge nozzle. The pump shall be designed to handle silt, clay, pebbles & vegetation those are normally associated with river / surface water.

The SS heavy duty strainer shall be provided at pump suction so as to restrict the entry of oversize solids / floating material in order to run pump set without clogging and interruption. The strainer shall have sufficient suction area (min. 4 times of bell mouth / pump inlet area) and openings throughout its surface to let water in easily. The size of the holes on strainer shall not be more than max. permissible solid handling size/capacity of pump or lower as per the permissible solid handling capacity of pump and as recommended by pump vendor. **The strainer shall be supplied by pump vendor only as per the area of opening and opening requirement to suit the offered pump design.**

CASING

Pump casing shall be volute type, of robust construction and designed for high efficiency. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing can be provided with wearing rings / wear plates.

IMPELLER

Impeller shall be enclosed or suitable as per manufacturer's design, single suction type with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall be designed to handle silt, clay, pebbles & vegetation those are trapped with raw water of river. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials.

Impeller shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration. The Impeller shall have back vanes or suitable design features to balance axial thrust.

IMPELLER NUT

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

SHAFT SEAL / MECHANICAL SEALS

Double mechanical seals shall be provided to protect the motor from ingress of water along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with an electrical monitoring system for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

BEARINGS

Pump set shall have double anti friction grease lubricated bearings. The bearings life shall be minimum 40,000 hrs of operation. Bearings shall be greased for life –i.e. shall not require any re-greasing . Bearings shall be of SKF / FAG make only.

AUTO COUPLING / GUIDE PIPE / LIFTING CHAIN

Each pump shall be supplied with pump connector unit in order to connect connector unit to pump support bracket with rubber diaphragm to make leak proof joint and fixing it to the concrete floor of the suction well. The design of the automatic coupling system shall be such that the joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails / wire rope from access level. The pedestal of the automatic coupling system shall be integrally cast with the delivery bend thereby obviating the need of separately bolted CI Duck Foot

Bend. It shall be provided with all necessary fixtures like guide wire / guide pipe for guiding the pumps during lifting/lowering.

Each pump shall be provided with a stainless steel lifting chain in conforming to relevant standards. The lifting chain shall be provided with dual 'O' Rings / shackles in SS-304 at every about 1.5m C-C for intermediate level support of pump and changeover of hoist hook during lowering and lifting

Each pump shall be provided with a stainless steel guide pipe / wire rope of required length.

LIFTING HOOK

To "fish out" a vertical submerged pump set from the wet well (even if a chain has not been attached to the lifting hook prior to the pump set being lowered) the pump shall have a self centering lifting hook. Its design shall be such that the lifting chain's hook can be engaged to the pump's lifting hook without the need for man to enter the wet well.

INDUCTION MOTOR (Submersible)

The submersible motor shall be Induction, Squirrel Cage, and Dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	$\pm 10\%$
Frequency variation	:	$\pm 5\%$
Combined variation of		
Voltage & Frequency	:	$\pm 10\%$

The Motor shall be generally designed to have performance characteristics like Nominal efficiency, Locked rotor current, etc. in line with IS: 12615:2018. (Efficiency minimum IE2 of IS: 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be min. 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump / sub. pump / driven equipment should be selected as per table of safety factor provided for Squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage & star-delta starting. Motor shall be capable of starting and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS 8783-1978 for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS 4800 (part-VII): 1970 for dry type motors. The corresponding Class of insulation shall be Class F with temperature rise limited to Class B. However, however for motors to be operated on VFD's , only Class "H" insulation with temperature rise limited to Class F is allowed and motor shall be inverter duty type and to suit for speed variation from 50% to 100% or higher..

As the cable resistance method, due care is taken to account for the correct hot and cold resistance of windings.

If these pump's motors are to be used with Variable Speed Frequency drives (VFD's) than :

- ❖ The motor insulation shall be Vacuum Varnish Impregnated instead of Dip Varnishing or Trickle Varnishing with double insulation coating.
- ❖ The motor insulation is to be of Class "H" only
- ❖ Current insulated bearing/s (preferably NDE) required for motor ratings above 200kW.

Terminal chamber shall be of IP 68 type construction to eliminate entry of storm water and dust. The Terminal chamber should be isolated from the motor chamber to prevent entry of liquid / moisture in the motor chamber through the terminal chamber. The terminal shall be the stud type with necessary plain washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

PROTECTION

Protection against increase in stator winding temperature (15 Deg. C) shall be provided. Minimum three number thermostats / bimetallic switches in series shall be provided to sense the stator winding temperature.

Sensors are to be provided to detect if leakage of water into the oil housing is above 30% concentration. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The required control unit to process these safety signals & with potential free contact o/p for alarm / trip shall be provided by pump vendor for suitable interlocking in starter circuit and /or PLC.

Manufacturer shall provide Pump Monitoring Unit (PMU) with each pump set.

SUBMERSIBLE CABLE

A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables. The cable shall be of sufficient length and shall be brought out of the submerged motor without joint to terminate in junction box / control panel, located in LT panel room /outside the wet well.

Power as well as Control Cables shall be of Dual Sheathed EPRS / PVC Armored type with required no. of Copper Core, round type and of required size as per design requirement.

The power cable shall be PVC insulated and PVC sheathed, flexible, 3.5/4.0 core round type. The size of the conductor shall be adequate for continuous use under water and air. Cable half/full core as per design to be used for earthing. The size of the conductor and length of cable shall be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

The control cable shall be PVC insulated PVC sheathed, flexible, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor, Bearing temperature sensor, level sensor (Thermostats/ bimetallic switches/RTD) of 1.5/2.5 sq.mm, multi strand copper conductor of required number shall be provided or as required as per design. Control cable shall be with minimum 1 no. spare core.

The cable connection to the motor entry should be such that cable fitment should be possible at the site.

Earthing of the motors shall be done in accordance with the relevant provisions of IS:3043-1966 for the purpose of earthing these motors, earthing connection may be made to discharge pipe.

MOTOR COOLING

The motor cooling shall be normally by surrounding water. However jacket cooling with in-built overflow or such suitable design of other method of jacket cooling shall be provide as specified in process data sheet / scope of work or if specified in BOQ.

C. MATERIAL OF CONSTRUCTION

The specific requirement shall be considered as under:

Pump Casing	CI IS210 Gr FG 260
Casing wear ring	CF8M / Bronze, IS 318 Gr. LTB 2
Suc. cover/Oil chamber/ Mot. casing	CI IS210 Gr FG 260
Shaft	AISI 410
Shaft sleeve	AISI 316 (if applicable)
Impeller / Impeller Nut	CF8M / Bronze, IS 318 Gr. LTB 2
Auto Coupling Unit	CI / WCB
Motor Jacket (if applicable)	SS 304
Guide rail pipe	Heavy duty min. 50 mm dia. of SS 304 of suitable length
Lifting Chain	SS-304, Min. equivalent to sump depth + 3 m with dual 'O' Rings/ shackles at every about 1.5m C-C.
Suction Strainer	SS 304
Bolts, Nuts, Fasteners, etc.	SS 304 (All, Wetted & Non-wetted)
Cable length (each run)	Min. equivalent to sump depth + 10 m

The above MOC is min. requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

PROGRESSIVE-CAVITY PUMPS (SCREW PUMPS)

Pumps shall be of the type in which a pumping action is generated by a helical rotating eccentrically within a resilient stator in the form of a double internal helix. The eccentric motion of the rotor shall

maintain a constant seal across the stator as it travels through the pump to give a uniform positive displacement.

Pumps shall be arranged generally with a single shaft seal at the suction end. Mechanical seals shall be used in case of clear solution or else gland packing shall be used for sludge / abrasive fluids. If a flexible shaft is used to accommodate the eccentric motion, a corrosion-resistant shroud shall be fitted to prevent fiber build-up on the shaft. Enlarged inspection access holes shall be fitted to the suction chambers of all pumps for periodic removal of accumulated debris.

The shaft bearings shall be positively isolated from the fluid being pumped.

The rotor material shall be selected for corrosion and abrasion resistance for the fluid being pumped, and for prolonged service life. Hard chrome or other approved coatings shall be of 75- 100 micron thickness and shall be diffused in to the base material. The rotor shall generally be single-stage and shall incorporate not less than 360° of twist, but for high-head applications, it may be necessary to use more than a single-stage.

The stator shall be of a resilient material selected for chemical and abrasion resistance for the fluid being pumped.

Pump speed shall suit the application. The pump shall operate at an optimum rubbing speed depending on the abrasive and viscous characteristics of medium to be handled. For Effluent and sludge handling maximum rubbing speed shall be as follows:

Effluent Sludge	≤ 1.5 m/sec.
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Where variable delivery output is needed, the pump shall be provided with a variable-speed drive. The size and speed range of the pump shall ensure that the highest expected duty point shall lie within the available speed range. Variable drive and VFD operated motor shall be as per electrical specifications.

Pumps shall normally be driven by a fixed-speed electric motor through reduction gearing and the combined drive shall be continuously rated. Pump and motor shall preferably be mounted in-line on a common base plate. Alternatively, the drive motor may be top-mounted above the pump to minimize floor area, and shall be connected by external V-belts and pulleys. V-belt drives shall have full guards of the type that allow the belts to be observed without removal of the guard. Facilities shall be provided for ready adjustment of belt tension.

Coupling guards shall be provided, which shall be rigid, securely fixed, and designed so that removal is not necessary during normal operation, routine maintenance and routine inspections.

All motor enclosures shall be provided with ingress protection to IP55. Motor anti-condensation heaters shall be provided and shall be suitable for use on a 220V single-phase, 50Hz supply if required based on drive rating as per electrical specifications.

All bearings shall have a B10 design life of not less than 40 000 running hours and shall be designed for loading 20% in excess of calculated maximum loading.

Pumps shall be fitted with individual dry-running protection through suitable temperature sensing device imbedded in casing/stator to initiate pump trip.

MATERIAL OF CONSTRUCTION

Pump Housing	CI IS 210 Gr FG 260
Rotor	SS AISI 410 Hard Chrome Plated
Shaft	SS AISI 410 Hard Chrome Plated
Stator	Nitrile black
Type of drive	Gear Box
Base plate	MS Epoxy Painted
Seal type	Gland packing

FLOATING AERATOR

The unit supplied must be able to operate both in mixing and in aeration mode controlled completely independently of each other. Unit must have two distinct modes of operation; simultaneous aeration and mixing mode, and mixing only mode. The aerator consists of an electric motor and regenerative blower located above the water surface. The motor is connected to a hollow shaft with a protective housing positioned at a 45° angle downward into the water. The hollow shaft drives a mixing propeller and Saturn Ring-type diffuser beneath the water surface. Attached to the primary propeller is a Saturn ring diffuser, which disperses the air as fine bubbles (2.0-2.5 mm diameter) into the stream of displaced water beneath the water surface. Aerator with submersible motor & gear box are not acceptable.

Aerator / Mixer Components:

AERATOR DRIVE MOTOR

- The motor shall deliver required horsepower at 750 RPM nominal and shall be rated for 415 volts, 50HZ/cycle, 3phase service, IEC Motor.
- Motor enclosure configuration shall be totally enclosed, fan cooled TEFC and meet IP55/56 specifications.
- Motor frame shall be made of cast iron end brackets and cast iron body. Fan material shall be carbon steel, aluminum, or propylene with metal hub. Fan cover shall be cast iron or carbon steel with epoxy polyester paint - 50 micrometers thick minimum.
- The noise level of the motor shall be less than 60DB and in accordance with IEC specifications.

BLOWER

The equipment shall include a high efficiency regenerative blower sized to provide sufficient airflow to yield the rated oxygen transfer capacity. Each blower includes the following features:

- Maintenance free and CE compliant - Declaration of Conformity on file
- Aluminum alloy construction
- Inlet and outlet sound attenuating silencers to minimize noise.
- Inlet filters (preferably two stage filter) with epoxy-coated wire mesh media rated for 70 microns or better.
- The blowers shall be tropicalized for corrosion resistance and deliver required horsepower maximum rated for 415 volts, 50 Hz cycle, 3-phase service. Blower motors shall be wired separately.

MOUNTING FLANGE:

The mounting flange shall be stainless steel and shall permit removal of the aerator mechanism leaving the motor in place. The mounting flange will allow the aerator to be rotated out of the water for inspection, maintenance or storage.

SHAFT/UNIVERSAL JOINT COUPLING

- The shaft shall be stainless steel full-welded to a forged carbon steel universal joint coupling. The shaft must be hollow to promote maximum air flow and oxygen transfer. Units with solid shafts are not acceptable. The shaft shall be dynamically balanced.
- The universal joint coupling shall include standard grease fitting for maintenance lubrication. Units which utilize flexible couplings to attach to the shaft of the motor are not acceptable.
- Units supplied with couplings that require alignment are not acceptable.

- The shaft shall be stabilized by a replaceable water lubricated bearing located within one inch from the propeller hub. The area of the shaft supported by the bearing shall be fitted with a replaceable hardened non-metallic sleeve.

HOUSING:

The housing shall be stainless steel and flanged for mounting to the aerator. The housing shall form a guard around the hollow shaft and support a field replaceable, water-lubricated bearing press-fitted into the housing lower end. Water lubrication holes shall penetrate the housing in the area surrounding the bearing.

BEARING

- The aerator shall be supplied with a field replaceable water lubricated lower support bearing. The bearing shall be constructed of an appropriate material for the application inside a fiber backing. The bearing shall be press-fitted into the housing to allow ease of replacement.
- Units utilizing a cantilever design without a lower support bearing or regreaseable tapered roller bearings are not acceptable.

SLEEVE:

The replaceable hardened non-metallic sleeve shall be the only moving part in contact with the electrometric bearing and shall spin with the shaft as one unit. The sleeve shall be solid and homogeneous.

PROPELLERS:

- The stainless steel mixing propeller shall be specifically designed to maximize oxygen transfer and mixing characteristics. Propellers shall be self-tightening such that the propeller threads tighten on the shaft threads during normal operation. The entire flow of air shall pass through the propeller via the hollow drive shaft along the axis of the propeller hub.
- The propeller design shall be tested in clean water and shown to draw a minimum of 85% of the recommended full motor amperage load at nameplate voltage and power factor. The propeller shall be designed to allow easy removal and replacement in the field.

SATURN RING / DIFFUSER:

The Aerator shall be equipped with a stainless steel secondary Saturn Ring diffuser, smaller than the mixing propeller, consisting of two concentric rings of differing diameters fixed to the diffuser body. The rings shall be specially designed to maximize oxygen transfer and to prevent self-aspiration when the regenerative blower is turned off to accomplish anoxic mixing. The entire flow of forced air shall

exit through the propeller /atomizer opening.

VORTEX SHIELD:

A vortex shield shall be furnished with each mounting assembly to eliminate the formation of vortices, maximize shaft airflow and prevent cavitations damage to the propeller during operation. Units without vortex shields are not acceptable.

FLOTATION:

The aerator flotation assembly shall consist to 3 or 4 pontoons constructed of molded low-density polyethylene with ultraviolet inhibitor, filled with urethane foam. The pontoon shape shall be designed with smooth, beveled edges to allow freezing into ice without breakage. The pontoons shall be connected by galvanized or stainless steel structural members to prevent corrosion. To allow for servicing by not removing the aerator from the flotation, the flotation assembly shall be designed so the aerator may be rotated completely out of the water and taking care of water level fluctuations. Structural aluminum is not acceptable. Welded stainless steel floats will not be acceptable.

ELECTRICAL SERVICE CABLE:

Cable shall be CSA/UL approved for severe environments, suitable for underwater service and one continuous length. The cable shall be jacketed, flexible stranded cable with individually wrapped conductors.

CAST IRON OPEN CHANNEL GATES

GENERAL:

The construction of cast iron open channel gate shall be strictly in accordance with the specifications mentioned hereunder. The open channel gate shall be capable of performing the isolation duties in water / waste water treatment plant for those applications where the height of water is at least 300 mm less than the height of opening / shutter. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

DESIGN:

The open channel gate shall comprise of frame suitable for mounting in the parallel side walls of the channel. The frame shall be self-contained type with a yoke on top for mounting of the operating arrangement. The shutter shall move within the frame guides and shall be provided with suitable connecting arrangement to enable connect it to the spindle.

Water sealing on sides and bottom shall be affected by means of non-corroding seating faces secured in groves of frames and remaining in forced contact with corresponding sealing arrangement mounted on shutter. Bottom sealing arrangement shall be flush bottom type to ensure that invert level of channel on either side of gate remains flush with the invert of the gate.

The spindle shall be rising type and provided with stop nut to avoid over closing of gate. The rising spindle shall be provided with transparent scratch proof and UV resistant polycarbonate cover tube to protect the threaded portion from the effect of dust, dirt and rain. The operating arrangement shall be manual or electric as specified elsewhere in the tender specifications. In case of manual operation operating mechanism should be such that the effort required to open / close the gate does not exceed 18 kgs with diameter of hand wheel / crank restricted to max. 750 mm. However for all gates of size above 1000 mm x 1000 mm or above 1 m² shutter area shall be gear operated type only.

MATERIAL OF CONSTRUCTION:

The material of construction for various components shall be as under:

Gate frame, shutter/Door	Cast iron IS 210 FG 200
Side Guides	Cast iron IS 210 FG 200
Seating faces	Stainless Steel ASTM A 240 type 304
Rubber Seals	EPDM Rubber to ASTM D 2000
Rubber seal retainer bar	Stainless Steel ASTM A 240 type 304
Assembly bolts, nuts and fasteners	Stainless Steel ASTM A 276 type 304
Stem & connecting pin	Stainless Steel ASTM A 276 type 304
Yoke	Mild Steel to IS : 2062 grade A, epoxy painted
Headstock	Cast iron IS 210 FG 200
Spindle cover tube / pipe hood	Polycarbonate

WALL THIMBLE MOUNTED CAST IRON SLUICE GATES

GENERAL:

The construction of cast iron sluice gates shall be strictly in accordance with the specifications mentioned hereunder. The Sluice gates shall be capable of performing the isolation duties in water / waste water treatment plant & pumping stations for isolation of flow in & out of a closed conduit as well as in those applications where water head is more than the height of shutter / opening. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

The Sluice gates shall be Wall thimble mounted only except for shallow channels. For shallow channels of up to 3.5 meter depth with water head not exceeding 2.0 meter and Gate/ Shutter area not exceeding 1.5 m² wall mounted gates can be accepted instead of wall thimble.

The gate shall be designed for seating and unseating head of minimum 5m liquid depth or as per design requirement (except for shallow channels / units <5m total height for which it shall be subject to top of channel / unit and accordingly head shall be as per actual full height).

DESIGN & CONSTRUCTIONAL DETAILS:

The sluice gates shall be manufactured generally as per IS-13349-1992. The constructional features and details of components of the required gates are to be as under:

GATE FRAME:

- The gate frame will be made from cast iron and shall be sufficiently rigid to withstand the designated water head. The gate frame shall either be flat back type or flange back type to suit the designed head and site condition.
- Back flange of the gate aperture frame to be precisely machined flat and drilled to engage with the Cast iron wall thimble mounted on the wall. A rubber gasket will be provided between the wall thimble and the gate for ease in future dismounting of the gate for repairs / replacement and seal any leakage between the flange of frame and wall thimble.
- The gate frame of these sluice gates shall either be self-contained type or non-self-contained type depending upon site requirement. In case of non-self-contained gates the frames shall have short length extension guides and shall be without yoke at their top. The length of extension guides in such cases shall be sufficient to engage atleast half the overall vertical height of door when the gate is full open and shall be in accordance with the relevant provisions of IS-13349.

In case of self-contained gates the frames shall have full length extension guides and shall be provided with a yoke at their top. The length of extension guides in such cases shall be sufficient to engage the overall vertical height of door when the gate is full open position.

WALL THIMBLE:

- The Wall thimble will be made from cast iron for placement in the concrete wall. Its front flange will be machined, drilled and tapped to match with the frame flange.
- The cross section of the thimble shall be F shaped and the depth of thimble shall be minimum 300 mm long. Gates subjected to high unseating heads shall have thimble cross section shaped E.
- To permit entrapped air to escape as the thimble is being encased in concrete, cast holes of 40mm diameter shall be provided at the bottom of wall thimble in each entrapment zone.

GATE SLIDE / SHUTTER / DOOR:

- The gate slide / shutter / door will be made from cast iron and shall be sufficiently ribbed to withstand the designated water head.
- The gate slide / shutter will be provided with integral pocket to house the thrust nut used to connect the stem with the slide.

SEATING/SEALING FACES:

- a. Materials: These should be of Stainless steel or Bronze or as specified.
- b. Fitment: The facings shall be attached to flat / rectangular / dovetailed machined faces of gate frame and door, depending upon the applicable water head, and be secured in place using taper screws. The taper screws adopted for facings shall be of same material as that of the seat facings.
- c. The front faces of integral extension guides which can come in contact with the sealing faces of door while opening, shall also be fitted with sealing faces of the same material as that of the sealing faces on door. This is required to offer non corroding smooth sliding surfaces to the sealing faces of door/shutter during its vertical travel for opening and enhance the effective life of gate.

d. Finish: The mating seating/sealing faces on the gate frame and door shall be precisely finished for proper contact. They should be so finished that the clearance or gap, if any, between the mating sealing faces, in gate closed position, does not exceed 0.1mm.

WEDGING DEVICES:

- The sluice gates shall be provided with individually adjustable wedging devices to ensure forced contact between frame and shutter seat facings, when the gate is in closed position.
- The gates meant for seating head shall be provided only with side wedging devices. Gates meant for unseating head of sizes larger than 600 mm, shall be provided with side top and bottom wedging devices or with side and top wedging devices and flush bottom closing arrangement as required.
- The wedgin devices comprise of wedge brackets fitted on gate aperture frame and door. The wedge bracket on frame shall remain in fixed position and those on door shall be adjustable or vice versa. A sort of slot and tennon arrangement shall be provided on base of wedge brackets to prevent any tendency to shift. Provision shall be made to calm the adjustable brackets firmly in adjusted position.
- The wedging devices shall be made of cast iron. If the wedges/wedge blocks of wedging devices are of Cast Iron, then these are to be lined with contacting faces of the same material as that of sealing faces attached to the gate frame and door.

CONVENTIONAL OR FLUSH BOTTOM CLOSING:

The sluice gates shall be provided with conventional or flush bottom closure arrangement as required.

Generally as a standard the **gates shall be provided with flush bottom closing only especially for gates mounted on bottom of channel**, etc. Only the gates mounted above the floor level and having required clearance below for applications like inlet pipe isolation at elevated level, etc. shall be with conventional bottom closing.

The sluice gates provided with conventional bottom closing arrangement involve corrosion resistant metallic contacting sealing faces at the bottom sill of gate. In such cases, the invert of the gate is

required to be kept above the floor of the channel / chamber by at least 150mm to 250mm depending upon the size and type of gate. The contractor should verify whether this clearance is available at the site of installation for fitting a conventional bottom closure gate.

In case of conventional closing gate, if the invert of the gate is kept at the same level as that of the channel/chamber floor, then there remains a slot or a groove at the invert of the gate. Debris, dirt etc. which may settle in this slot and may not allow the gate to close properly and this may give rise to heavy leakages while in operation. With a view to avoid this, in situations where the invert of the gate is to remain at the same level as that of the channel/floor, a Flush Bottom closing gate instead of Conventional Bottom Closing gate should be provided.

Flush Bottom Closing shall involve a flexible rubber seal at the bottom of the gate, mounted either on the shutter or on the frame, ensuring that the sealing face remains flush with the floor. The cast iron bar fitted at the bottom of the frame is required to be embedded in the channel / chamber floor and for this a cut out / recess of ample dimensions is required to be provided beneath the waterway opening along the gate invert, while constructing the floor. The dimensions of this cut out shall be provided depending upon the feasibility to do so as per actual site conditions.

This cut out/recess is to be later on filled up with removable asphalt or loose concrete mixed with sand dust or vermiculate after putting the gate in position so that it is possible to break open this second stage grout for removal of the gate in future.

The rubber seal employed shall be made of EPDM or Neoprene rubber and the rubber seal retainer bar as well as the fasteners for fitting the rubber seal and the retainer bar are of stainless steel.

GATE OPERATING HEADSTOCK/LIFT MECHANISM :

- The operating headstocks shall be designed in such a manner as to permit the gate operation by a single person under the specified maximum operating head with an effort of less than 18kgs on the crank or hand wheel with a radius not exceeding 375mm. Vendor shall provide torque calculations in support of same.
- The headstock may be ungeared or geared type and the geared headstock may be either of single speed or of double speed, as might be necessary to make it convenient for one person to open or close the gate as fast as practicable. Two speed headstocks shall be supplied with gates requiring higher hoisting capacities. In this type of headstock the low speed is meant for crack

opening the gate when the effort required to open the gate is maximum and the high speed is meant for further faster opening after the gate is crack opened.

- Geared headstock shall be supplied with easily removable crank handle or handwheel with a radius not exceeding 375mm.
- All the gears of geared headstock shall be kept completely encased in cast iron housing to protect them from damage, dirt, dust, water etc. and other atmospheric effects and thus ensure their smooth operation. Grease nipples shall be provided at proper places for lubricating with grease.
- Headstock meant for mounting on operating platform shall be supplied with a pedestal/floor stand to provide a convenient operating height of approximately 900 mm. The pedestal of the headstock shall be provided with a covered window opening to enable cleaning and greasing of stem threads.

LIFTING SPINDLE/STEM :

The sluice gates shall be supplied with Rising type lifting spindles/stems. The stem shall be provided with acme / square threading, length of threaded portion being about 400mm more than the height of waterway opening. This much extra length is required to allow for a minor variation of approximately 100mm on either side of the specified height of operating platform.

The design of stem will be done as per the provision in IS-13349.

STEM BLOCK / CONNECTING BLOCK / THRUST NUT:

The rising type stem shall be connected to the door through a stem block/thrust nut housed in a ribbed pocket cast integral with the door. The bottom end of stem shall thread into the stem block and is locked in place by a set screw to prevent the stem from unscrewing. The Stem block shall be cast Bronze or Gunmetal.

SAFETY STOP NUT:

The stem shall be provided with a safety stop nut to prevent the chances of over closing of gate which may otherwise damage either the stem or the lifting platform. The stop nut shall be furnished with a set screw for setting it in a fixed position after the gate is installed. Upon installation the safety stop nut should be set in such a way that its bottom remains about 1 to 2 mm away from the top of headstock, in gate closed position.

In case of stainless steel stem, the stop nut shall also be of stainless steel material of the same grade.

STEM/SPINDLE COUPLINGS:

For ease in transportation and handling, maximum length of one piece stem shall be restricted within 5 meter length. Where the stem are required to be furnished in more than one piece, threaded stem couplings shall be furnished to interconnect different sections of the stem. The couplings shall have provision for pinning after inserting in the threaded end of the stem.

In case of stainless steel stem, the couplings shall also be of stainless steel material of the same grade.

STEM GUIDE BRACKETS :

Longer stems shall be provided with sufficient number of stem guides to prevent buckling of stem. The stem guide bracket to be provided shall be Adjustable Centre Type - wherein a separate stem guide is bolted on to the wall bracket. The stem guide shall be adjustable in the slots on wall bracket in a direction perpendicular to the face of wall. Wall bracket should also offer minor adjustment in the direction parallel to the wall.

The stem guides shall have machine bored split journals to facilitate erection. The journal shall be lined with brass/gunmetal bush.

PIPE HOOD FOR STEM :

A Pipe hood shall be provided on the top of headstock in case of rising spindle/stem gates to cover the spindle threads for protection against damage, dirt, dust, water etc. It shall be made of transparent fracture resistant polycarbonate material. The pipe hood shall have vent holes to prevent condensation.

GATE OPENING INDICATING ARRANGEMENT :

Gate opening indicating arrangement shall be provided to indicate the position of the shutter. This shall comprise of scale mounted on the pipe hood and an indicator nut mounted on the rising spindle to show the extent of the opening and closing. The minimum scale graduation shall be 25 mm.

MATERIAL OF CONSTRUCTION:

The material of construction for various components shall be as under:

Gate Frame, Shutter , Thimble,	Plain Cast iron IS 210 FG 200
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Headstock, Wedges, Stem Guides	Plain Cast iron IS 210 FG 200 Stem Guide shall be with LTB-2 Lining
Seating / Sealing Faces & Wedge Lining	Stainless Steel ASTM A 240 type 304
Rubber Seals (If Applicable)	EPDM Rubber to ASTM D 2000
Rubber Seal Retainer Bar (If Applicable)	Plain Cast iron IS 210 FG 200 / Stainless Steel ASTM A 240 type 304
Stem, Stem Guide Brackets, Coupling & Stop Nut	Stainless Steel ASTM A 276 type 304
Assembly Bolts, Nuts and Fasteners	Stainless Steel ASTM A 276 type 304
Yoke (If Applicable)	Mild Steel to IS : 2062 grade A, Epoxy Painted
Stem block	Leaded tin bronze to IS 318 type LTB2
Lift nut for manual ungeared	Leaded tin bronze to IS 318 type LTB2
Pipe Hood for Stem	Transparent fracture resistant polycarbonate material
Operation	
Lift nut for manual geared / actuator Operation	As per gear box / actuator manufacturer Std.

VALVES

General

Valves shall be as per Internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS 6392 or BS 4504. Flange drilling should confirm to IS 1538

Valves shall be double flanged type (unless the end connection is permitted otherwise as specified in specifications for each valve below / in process data sheet) and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Valves shall be embossed with flow direction arrow.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. For all type of valve/gates (including open channel, thimble mounted, etc.) gear mechanism design and makes shall be as per manufacturer standard

The valve stem, thrust washers, screws, nuts and all other components exposed to the sewage shall be of a corrosion resistant grade of stainless steel.

Valves shall be free from sharp projections.

For valves with extended spindle / shaft following shall be considered / provided:

- Extended spindle MOC and size to be confirmed by valve vendor
- Head stock / bracket supply shall be in valve vendor scope only. Valve vendor also to provide details and MOC of the same in GAD.
- For extended spindle the coupling & guide bracket details shall be provided by vendor. Generally it is desired to have two nos. universal Couplings (one on top / below headstock and one in bottom above gear box / valve body). In case of long spindle lengths muff couplings at about every 3m distance. Shaft guide bracket /support shall be provided if extension spindle is more than 3 m long.

The MOC specified below for various valves is min. requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

VALVES:-

11.1 SLUICE / GATE VALVES

Design Requirements and construction Features

Valve shall be non-rising spindle type sluice valve confirming to IS 14846 having PN 1.0 / PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

For Valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged / threaded type.

Body of the valve shall be designed for 1.5 times the rating of the valve.

Valve flange face shall be parallel to each other and flange face should be at right angle to the valve centerline.

Back side of valve flange shall be machined or spot faced for proper seating of bolt head and nut.

Wherever extension spindle is provided, the valve shall also be provided with suitable headstock.

Valve shall close with clockwise rotation of the hand wheel. The direction of closing shall be marked on the hand wheel.

Valve shall be non-rising spindle type and rated for nominal pressure of PN 1.0 / PN 1.6.

Accessories shall be provided as under:

1. Valves above 300 mm size shall be provided with Repacking arrangement as per IS 14846.
2. The Valves 600 mm & above size shall have channel and shoe arrangement as per IS 14846.
3. The Valves 450 mm size & above shall have spur / bevel gear arrangement as per IS 14846.
4. All Valves shall have valve's OPEN / CLOSE indicator arrangement as per IS 14846.

Materials of Construction

a) Body, Bonnet and Wedge	:	DI to IS 1865 Gr. 500/7
b) Spindle Nut	:	Bronze to IS 318 Gr LTB2
c) Spindle	:	SS to BS 970 Gr 304 S16
d) Seat rings	:	SS to BS 970 Gr 304 S16
e) Back seat bush	:	Bronze to IS 318 Gr LTB2
f) Shoe & channel linings	:	SS to BS 970 Gr 304 S16

Note: Material test certificates shall be furnished for all the above parts.

For Valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged / threaded type.

However, Valves 15 mm to 40 mm size shall be generally as per API 6D/API 602 and having Carbon Steel Body (Body: forged carbon steel A105 / cast carbon steel Gr WCB, Trim: 13% Cr) in Class 150 or higher rating and shall be screwed / flanged ended.

11.2 NON RETURN VALVES

Design Requirements and Construction Features

Valve shall be free from sharp projections which are likely to get clogged with stringy materials.

For Valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged / threaded type The valve shall be suitable for mounting on horizontal pipe line.

The internal parts shall be easily accessible for inspection through inspection hole.

Hydraulic passages and doors shall be designed to avoid cavitations.

Valve body shall be designed for 1.5 times the rated pressure.

Valve shall be of swing type or ball type. Ball type valve must house a freely moving ball in such a way that return flow is effectively prevented.

Valve shall be quick closing type with non-slam characteristics in case of swing type. The non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external lever/dampening arrangement.

Flow direction shall be clearly embossed on the valve body.

Valve flange face shall be parallel to each other and shall be at right angles to valve centerline. Flange back shall be machined or spot faced for proper seating of bolt head and nut.

Valve shall be rated to PN 1.0 / PN 1.6 bars

Accessories shall be provided as under:

1. Valves above 300 mm size shall be provided with by-pass arrangement as per process requirement as per IS 5312
2. Valves above 300 mm size shall be provided with drain plugs as per IS 5312.
3. Valves above 450 mm size shall have support foot as per IS 5312.

Materials of Construction

a) Body, Cover, Doors & Hinge	:	DI to IS 1865 Gr. 500/7
b) Body Ring	:	SS to BS 970 Gr 304 S16
c) Door Ring	:	SS to BS 970 Gr 304 S16
d) Bearing bushes	:	bronze to IS 318 Gr LTB2
e) Ball (if applicable)	:	to be with EPDM Rubber

However, Valves 15 mm to 40 mm size shall generally as per API 6D/API 602 and having Carbon Steel Body (Body: forged carbon steel A105 / cast carbon steel Gr WCB, Trim: 13% Cr) in Class 150 or higher rating and shall be screwed / flanged ended

11.3 DUAL PLATE CHECK VALVES

General

All double flanged dual plate check valves shall conform to API 594-1997 and API 598 or its latest amendment for pressure rating PN 1.6 / Class 300. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from sharp projections which are likely to get clogged with stringy materials.

The internal dimensions and shape of the body, plates, etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve as per manufacturing standard.

The designs of the plates, hinge pin, stop pins, etc shall ensure free swinging of the plates. The spring action shall optimize the equal closing rates of each plate. The dual plates face shall have close face contact with the body seat ring in close position. Valves shall be designed for horizontal and vertical mounting position. The plates shall not vibrate under full or partial flow condition.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of plates, springs and hydraulic passages.

B. FEATURES OF CONSTRUCTION

BODY:

Valve body shall be double flanged. The minimum thickness of metal for body shall be as per directives given in the API 594 and shall be maintained throughout any section uniform. The Flange to flange dimensions shall be in accordance with manufacturing standard (tables 2A & 2B).

Body of the valve shall be fitted with removable seat ring securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Each check valve shall carry an embossed ARROW to indicate the direction of flow.

FLANGES:

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The finish on facing shall comply with MSS SP-6 / ASME B 16.5. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS 1538, Table IV & VI.

PLATES & HINGES:

Plates and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Plates shall be securely positioned on body seat face with the assistance of required nos. of spring or other devices. Plate seating face shall be renewable or uniformly deposited weld metal machined and lapped using good manufacturing process so as to provide leak less seating on body face ring.

The spring action shall optimize the equal closing rates of each plate. The plates shall be totally vibration free under full or partial flow condition.

INTERNAL WETTED PARTS:

Internal wetted parts shall be suitable for the specified service conditions. The term shall include but not be limited to hinges, pins, bolts, bearings and any other part in contact with the fluid medium other than the body, plates, trim, springs and pipe plugs.

OPTIONAL ITEMS:

1. Valves above 300 mm size shall have lifting eyebolts.
2. Valves above 600 mm size shall have support foot.
3. Valves above 600 mm size shall have Bypass arrangement as per process requirement.

11.4 KNIFE GATE VALVES

General

Knife gate valves shall be suitable for use in waste water and sewage water containing solids and fibrous wastes etc. These shall be **suitable for use** at suction and delivery side of pumps as well as in branch lines **in a sludge handling application** of treatment plant or a pumping station.

The valve should be provided with gate made of stainless steel and the gate should have beveled 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.

Design

The valve should preferably be bonneted up to 300 mm size and bonnet-less for higher sizes. Valves shall be of wafer lug type construction up to 450 mm size and full flanged construction

for higher sizes. The valve shall be provided with flange drilling to suit ANSI 16.5B 150# with raised face or DIN PN10 or IS 1538 -1993 flange connections in between pipelines.

The valves shall be designed to withstand minimum 10 bar pressure. It should be suitable for uni-directional application and should be able to withstand small bi-directional pressure.

The valve body should be cast and 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 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.

Bonneted type valves shall be provided with O-rings based arrangement to seal the rear opening and reduce the operating torque. Bonnet-less valves shall be provided with sufficient ply of stuffing seals in the in built stuffing box to seal the rear opening. 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. Replacement of stuffing seals should be possible to be carried out in installed condition of the valve but without there being line pressure.

The spindle should be double start threaded and non-rising type for compact & safe operation. Gate opening indicating arrangements should be provided to find out the extent of gate opening /closing.

MATERIALS:

The following material of construction shall be offered for the knife gate valves.

Body	: Bonnet less - Cast Iron FG 260 as per IS 210 / Ductile Iron
Knife gate	: AISI:304 Gr. ASTM A240
Retainer ring	: Ductile Iron / Steel hard chromed / Stainless steel Gr. CF:8
Inlet Seal	: EPDM
Spindle	: Stainless steel Gr. ASTM A276 Type 410 / 303
Spindle Nut	: Bronze to IS 318 GR LT B2
Stuffing plate	: Cast Steel ASTM A216 Gr. WCB
Stuffing seal	: Synthetic yarn with PTFE
Support channel	: Steel , epoxy painted

11.5 BUTTERFLY VALVE

Resilient seated butterfly valve short body shall be as per IS 13095/ BS 5155. Valve shall be suitable for mounting in any position.

For Valve size 150mm and above end connection shall be flanged and for sizes up to and including 125mm shall be flanged / full lug wafer type

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Butterfly valve where specified shall be electrically operated.

MATERIALS OF CONSTRUCTION:

SR. NO.	COMPONENT	MATERIAL
(a)	Body	Ductile Iron : IS 1865 Gr 500/7
(b)	Body ring	Stainless Steel; BS 970 Gr. 431 S29
(c)	Disc	Ductile Iron : IS 1865 Gr 500/7
(d)	Shaft	Stainless Steel; BS 970 Gr. 431 S29

(e)	Disc ring	EPDM Rubber
(f)	Bearing	Teflon

12.0 ELECTRIC ACTUATOR (APPLICABLE FOR VALVES / GATES)

All 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 headstocks 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 and shall be suitable for at least 15 minutes continuous operation. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute.

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 starter shall be equipped as follows as a minimum:

- a) A.C. electric motor.
- b) Reduction gear unit.
- c) Torque switch mechanism complete with set of torque switches for “Open” & “Close” position.
- d) Limit switch mechanism complete with set of limit switches for “Open” & “Close” position.
- e) 2 No. of Auxiliary limit switches to be provided for each direction in the switch mechanism in addition to the torque/limit switch for travel termination (if specified for any application in scope of work / process description & specifications)
- f) Hand wheel for manual operation.

- g) Hand-auto changeover lever with suitable locking arrangement.
- h) Local control switch / push buttons
- i) Forward/Reverse Integral starter
- j) 1 No. Set “Open”, ”close” and “Stop” buttons as applicable
- l) 1 No. Local – Off –Remote switch with padlocking facilities as applicable
- m) Space heater, 220V rated
- n) Position transmitter with 4-20mA analogue output for valve open/close position if requirement specified elsewhere in tender as per application.

The following relays/potential free contact shall be provided:-

- Full open
- Full close
- Torque switch open
- Torque switch closed
- Thermo switch / thermal overload relay tripped
- Selector switch position local-Remote-off
- Single phasing power supply failure
- Remote position feedback In the form of 4-20mA (if required / specified)

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque and shall be suitable for at least 15 minutes continuous operation. .

A.C. ELECTRIC MOTOR:

Each motor shall be fully tropicalised and suitable for operation in the prevailing climate conditions. They shall also be suitable for operating satisfactorily under variations of electric supply specified.

MOTORS:

The electric motors shall be of 3 phase, minimum Class 'F' insulated with temperature limited to Class B, high torque low inertia motors of 15 minutes rating, squirrel cage type with 'O' ring seal to provide complete environmental protection during long period of inactivity. The winding shall be impregnated to render them non-hydroscopic and oil resistant. All internal metal parts shall be painted. Motor shall be capable of at least 60 starts per hour.

MOTOR PROTECTION:

Following motor protection shall be provided:

- a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- b) Motor temperature shall be sensed by a thermostat to protect against Overheating.
- c) Single phasing protection.

MOTOR CONTROLS:

The reversing contactor starter and local controls shall be integral for actuator. The starters shall comprise mechanically and electrically interlocked reversing contactor of appropriate rating fed from a 220 V control transformer (120V AC for energization of contactors and 24V DC rectifier supply for local control for integral starter is also acceptable). The common connection of the contactor coils at the transformer shall be grounded. HRC type primary and secondary fuses shall be provided.

Local control shall comprise push buttons for open close and stop operations, and a local / remote selector switch lockable in the three positions as below:

Local control only,

Remote control plus local stop only,

Stop locked off - No electrical operation

Vendor should also make a provision for transmitting the mode selected to control panel and control panel will have corresponding indication lamps.

WIRING AND TERMINALS:

Internal wiring shall be of grade PVC insulated stranded cable of 650 V and of minimum 1.5 mm² copper for control circuits and of minimum 4 mm² for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type and they shall also be identified by numbers. Cable entries shall be suitable for suitably sized PVC cables.

ENCLOSURE:

The actuator enclosure shall be Weather Proof to IP-68.

REDUCTION GEAR UNIT:

Reduction gear unit shall be of the totally enclosed oil bath lubricated type. The gear box shall be provided with the first charge of oil lubricants and appropriate filling and drain connections. Gearing shall be adequate to open and close the sluice gates under full indicated maximum operating pressure differential at a speed sufficient to cover the full extent of travel.

The sluice gate operating equipment shall have a hammer-blow device to loosen stuck sluice gate or retrieve jammed sluice gate position.

The gearbox shall have suitable stops to prevent movement of shaft beyond fully open / close position. The gearbox shall also be designed for 15% more torque than maximum sluice gate / valve torque.

TORQUE & POSITION LIMIT SWITCH MECHANISM:

Each actuator shall be provided with both Open and Close torque limit switches, open and close (end position) limit switches for remote indication and interlocking plus two sets of auxiliary limit switches in each direction for intermediate position indication and interlocking if specified above for minimum provision in starter. Means shall be provided to prevent the open torque switch tripping during initial hammer blow effect. Torque protection reset shall not allow repeated starting in same direction when the control signal is maintained.

The torque switch mechanism shall function as follows to stop the motor on closing or opening of

the sluice gate, upon actuation by the torque when the sluice gate disc is restricted in its attempt to open or close.

The torque switch in the closing direction shall interrupt the control circuit if mechanical overload occurs during the closing cycle or when the sluice valve is fully closed. The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during opening cycle or when the valve is fully open.

The mechanism shall facilitate adjustment of the torque at which the switches are required to operate.

HANDWHEEL:

A hand-wheel shall be provided for emergency operation. The hand-wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency manual operation in a reasonable time.

METALLIC EXPANSION BELLOWS

Expansion bellow shall be in accordance with the EJMA/ ASME standard.

The bellows shall be metallic corrugated design of MOC as specified and shall have double flange with liner / internal sleeve. The Fatigue life expectancy considered for the Expansion Bellows shall be min. 3000 cycles. The drilling standard of expansion joint flange shall be matched on piping side to ensure proper alignment and bellows is not subjected to torsional forces due to misalignment. The expansion joint shall be single bellow design and shall be generally suitable for axial movement of up to total 30mm (20mm axial compression & 10mm axial extension). Further it shall be suitable accommodate angular misalignment of piping for up to min. 5mm / 3 degrees for installation.

To achieve maximum flexibility coupled with required resistance to pressure, bellows shall be formed with single or multiple walls using a number of concentric cylinders (multi-ply construction) of specified MOC, each longitudinally welded. However for the blower application the bellows shall be of multi-ply construction only.

The expansion joint overall length for up to 250mm size shall be 250mm and for rest above 250mm shall be 300mm.

Generally the expansion joint is provided of single bellow design as a dismantling / disassembly joint in piping near valve or pump or flow meter or such device or equipment for ease of removal and jointing. Tie Rods / Threaded draw bars attached to expansion joint assembly shall be provided for this application.

In case of bellows used for air piping application / in air blower discharge piping or such application witnessing vibration and temperature variations the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement.

In case of bellows used for diaphragm type dosing pump or such pulsating service the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement.

The austenitic stainless steel shall be welded using the T.I.G. welding method.

The weld end pipe shall be suitable for design pressure (Min. PN 10 or higher as per design) and for CS / MS weld end pipe shall be with min. corrosion allowance of 3mm for water /waste water application. However for blower application the bellows shall be designed for a working pressure of min. 1 Bar or higher as per design and for a temperature of min. 115 deg. C or higher as per design and for a velocity of min. 25 m/sec or higher as per design and the liner thickness shall be suitable for the same.

During installation the bellows as a practice shall always to be placed between two fixed points. Thrust block or saddle welded to pipe to make it fixed must be provided on both sides of EB. For blower application generally after the bellow the first support (saddle or suitable) shall be provided at 4D distance and second support 14D distance from bellows to dampen the vibrations.

The shipping bracket of bellows shall be removed only after installation of the bellows at site.

MATERIAL OF CONSTRUCTION

Component Description	Water / Sewage / Sec. Treated Indl. Effluent / Air Application	Indl. Effluent / Bio-Gas / Chemicals or Corrosive Application
Bellows	SS 304 (ASTM A 240 Tp. 304)	SS 316 (ASTM A 240 Tp. 316)
Internal Sleeves / Liners	SS 304 (ASTM A 240 Tp. 304)	SS 316 (ASTM A 240 Tp. 316)
Weld End Pipe	CS / MS	SS 316L
Flanges	IS:2062 with drilling as per IS:1538, PN10	IS:2062 with drilling as per IS:1538, PN10 with SS lining

		(all wetted portion with SS lining)
Tie / Limit Rods	Carbon Steel (CS) as per IS 1367	SS 304 / SS 316
Nut, Bolt , Hardware	CS as per IS 1367	SS 304 / SS 316

Note: For Chemical (Alum, polyelectrolyte, etc.) or Corrosive application the above specified MOC are minimum and higher / better / suitable MOC shall be provided as per the nature of chemical / fluid.

Expansion bellow shall be erected in lock condition by tie rod arrangement.

APPROVED VENDOR LIST FOR MECHANICAL EQUIPMENT

1	Submersible Non-clog Pumps / Submersible Centrifugal Pumps	Aqua / Kirloskar / Kishor / KSB / M&P (Wilo) / WPIL / ABS / ITT-Flyght
2	Drain / Dewatering Pumps (Submersible / Horizontal)	Aqua / Kirloskar / Kishor / KSB / Jyoti / M&P (Wilo) / WPIL / Jasco
3	Screw Pump	Roto / Netzch / Tushaco / Seepex / U T Pump
4a	Metering / Dosing Pumps – Reciprocating Type	Swellore / V.K. Pumps / Shapotoools / S.R. Metering / Milton Roy
4b	Metering / Dosing Pumps – Electronic Type	Swellore / Milton Roy / Prominent / Verito Engineering / ANT Pumps Positive Metering
5	Clariflocculator, Secondary Clarifier, Gravity Sludge Thickener	Eimco-KCP / HDO / Shivpad / Triveni / Voltas
6	Sluice Valves	Kirloskar / IVC / IVI / Fouress Engg. / VAG / AVK / G M Engineering / R&D Multiple
7	Non Return Valves (Single / Multi door) / Dual Plate Check Valves	Kirloskar / IVC / IVI / Fouress Engg. / VAG / AVK / G M Engineering / R&D Multiple

8	Butterfly Valves	Kirloskar / IVC / IVI / Fouress Engg. / VAG / AVK / G M Engineering / R&D Multiple / Audco
9	Knife Gate Valve	Jash / Fouress / Kirloskar / Vag / Orbinox / IVI
10	Sluice Gates / Open Channel Gates	Jash Engineering / IVC / IVI / R&D Multiple
11a.	Ball Valves / Plug Valves / Needle Valves (Metallic)	Audco / Intervolve / Kirloskar / Saunders / Saturn / Virgo / G M Engineering / BDK-Weir
11b.	Ball Valve (PP / uPVC)	GF-GEORG FISCHER / Dinesh Plastic / UNP / ASTRAL
12	HOT / EOT Crane and Pulley block.	Morris / Indef / Safex / W H Brady / JAPS / Anker
13	Air Blower	Kay / Swam / Everest / Usha Compressors / Gardner Denver
14	Agitator / Mixer	Remi / Schurtek / Fibre & Fibre / Rathi Vessels & Systems / Shivpad / Milton Roy / Triveni
15	D.I. Pipes	Electro Steel / Kejriwal / Lanco / Jindal / Electrotherm / Srikalahasthi
16	HDPE Pipes	Astral / Dutron / Duraline / Narmada / RIL (PIL) / Penwalt / Anjney / Jain Irrigation / Sangir
17	PVC / uPVC / CPVC Pipes	Astral / Supreme / Prince / Dutron
18	Control Valves / On-Off Valves – Pneumatic. Actuator Operated	ABB / Samson Control / Fisher Xomox (Sanmar) / Arca (Forbes Marshall) / MIL Control / Tyco Valves / SPX Valves
19	Dissolve Air Flotation unit (DAF)	Krofta/ K-pack/ Triveni
20	Surface Aerator	Euroteck / Jash-Invent / ITT Flyte / Sulzer-ABS / OVIVO
21	Volute Press	Emcon / Euroteck / Huber

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, final selection will be done with the approval of Engineer in charge.

APPROVED VENDOR LIST FOR ELECTRICAL EQUIPMENT AND COMPONENTS

ITEM DESCRIPTION	APPROVED MAKE
33 KV GAS INSULATED SWITCHGEAR PANEL -INDOOR TYPE (VCB/SF6)	ABB/SIEMENS/ SCHNEIDER
MV SWITCHBOARD & MV SWITCHGEAR -11 / 33kV - INDOOR / OUTDOOR TYPE (VCB/SF6)	ABB / C&S /CG POWER / GE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / AUTH. SYSTEM INTEGRATOR FOR SPECIFIED APPROVED MAKE OF OEM HERE IN
RING MAIN UNIT (RMU) MV - 11 / 33KV - INDOOR / OUTDOOR TYPE (VCB/SF6)	ABB / CG POWER / GE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS/EATON
PROTECTIVE / AUXILLARY RELAYS	ABB / C&S /ALSTOM / CG POWER / GE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
INSTRUMENT TRANSFORMERS (CT / PT / CBCT)	AUTOMATIC ELECTRIC / C&S/ AEP / ASHMOR / CG POWER / ECS / GILBERT AND MAXWELL / INDCOIL / KAPPA / PRAGATI / PRECISE
SURGE SUPPRESSORS	ABB / EMERSON / ERICO / MTL / OBLUM / PEPPERL+FUCHS / PHOENIX / RAYCHEM/ SCHNEIDER / SIEMENS / WEID MULLER
LIGHTNING ARRESTORS	ADITYA BIRLA INSULATORS (FORMERLY KNOWN BIRLA NGK INSULATORS) / CG POWER / DHRUVA/ ELPRO / JEF / JAYSHREE / OBLUM / WS
ALARM ANNUNCIATORS (SOLID STATE TYPE WITH LED ILLUMINATION) / FACIA ANNUNCIATOR	APLAB / ALSTOM / DIGICONT / ICA / IICP / MINILEC / PROCON INST. (P) LTD / PROTON ELECTRONICS
BATTERY CHARGER & DCDB	AMARA RAJA / AMCO POWER / AUTOMATIC ELECTRIC / CALDYNE AUTOMATICS / CHHABI ELECTRICALS / EXIDE / ELECTRONIC SYSTEMS / HBL POWER SYSTEMS / HIREL-HITACHI / MASS-

	TECH CONTROLS / UNIVERSAL INSTRUMENTS / SERVILINK
SMF / VRLA / NI-CD / LEAD ACID (PLANTE / TUBULAR) BATTERY	AMARA RAJA BATTERIES LTD / AMCO / EXIDE / FUJIYAMA / HBL POWER SYSTEMS LTD / LUMINOUS POWER / OKAYA
CONTROL AND RELAY PANEL	ABB / C&S/ ALSTOM / GE / EASUN REYROLLE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
POWER & DISTRIBUTION TRANSFORMERS (33/11KV & 11/0.433KV)	ABB / BHARAT BIJLEE / CG POWER / GE / RAYCHEM RPG LTD. / SCHNEIDER / TRANSFORMERS & RECTIFIERS INDIA LIMITED / VOLTAMP
SANDWICH BUS TRUNKING (BUS DUCT)	ABB / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS/C&S
PANEL CRCA / MS / GI PLATES & SHEET	ARCELOR MITTAL / ASIAN / ESSAR / JINDAL / SAIL / TATA
ALUMINIUM BUSBAR MATERIAL	BANCO / HINDALCO / JINDAL / STERLITE
COPPER BUSBAR MATERIAL	HINDALCO / JINDAL / STERLITE
ACTIVE HARMONIC FILTER (AHF) SOLUTION / PANEL	ABB / AMTECH / AB LIFASA / CONSULE NEOWATT / DANFOSS / EPCOS / FUJI ELECTRIC / LK-E&A (FORMLY L&T E&A) / NEPTUNE / SCHNEIDER / SCHAFFNER / SUBODHAN / SHREEM / TRINITY ENERGY
AC/DC POWER & AUXILLARY CONTACTOR	ABB / BCH / C&S / GE / INDO ASIAN / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / MITSUBISHI
MV CAPACITORS	ABB / EPCOS / SHREEM / UNIVERSAL / VISHAY
LV CAPACITORS / POWER CAPACITOR	ABB / ASIAN / BHEL / CG POWER / EPCOS / GE / HAVELLS / KHATAU JUNKER / MADHAV / MALDE / NEPTUNE / PRABODHAN / POWER MATRIX / SCHNEIDER / SUBODHAN / SHREEM / SIEMENS / UNIVERSAL /VISHAY
SOFT STARTER (MICRO PROCESSOR BASED)	ABB / CG POWER (EMOTRON) / DANFOSS / ROCKWELL / SCHNEIDER / SIEMENS / LK-E&A (FORMLY L&T E&A)
VVVF DRIVES (VFD)	ABB / CG POWER (EMOTRON) / DANFOSS / LK-E&A (FORMLY L&T E&A) / ROCKWELL / SCHNEIDER / SIEMENS / YASKAWA / NORD/AMTECH
LV SWITCHBOARD (PCC / PMCC / MCC / APFC etc.) PANEL AS PER IS/IEC 61439 OR LATEST EDITION	ABB / C&S / LK-E&A (FORMLY L&T) / SCHNEIDER / SIEMENS OR IT'S AUTHORIZED SYSTEM INTEGRATOR
AIR CIRCUIT BREAKERS (ACB)	ABB/ C&S/ LEGRAND / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
MCCB'S	ABB / C&S / GE / LEGRAND / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS

MPCB	ABB / C&S / INDO ASIAN / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
MCB / RCCB / RCBO / ISOLATORS	ABB / C&S / GE / HAVELLS / INDO ASIAN / LEGRAND / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / MOELLER / SCHNEIDER / SIEMENS
SWITCH DISCONNECTOR FUSE UNIT (SDF) AND SWITCH DISCONNECTOR ISOLATOR	ABB / C&S / GE / INDOASIAN / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
CHANGE OVER SWITCH	ABB / BCH / C&S / GE / HAVELLS / HPL / KRAUS & NAIMER / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
TEMPERATURE SCANNER WITH RS 485 MODBUS COMMUNICATION	ELECTRONET / MULTISPAN / MASIBUS / NIVAM / NISHKO / REDIX / SELEC
KWH / LOAD MANAGER / MULTI FUNCTION METER	ABB / C&S/ CONZERV / ENERCON / IMP / KRYKARD / LK-E&A (FORMLY L&T E&A) / MECO / RISHABH / SCHNEIDER / SECURE / SIEMENS
DIGITAL AMMETER / VOLTMETER / POWER FACTOR METER	ABB / C&S /ALSTOM / AE / ASIAN / CONZERV / IMP KRYKARD / LK-E&A (FORMLY L&T E&A) / MECO / MASIBUS / MULTISPAN / NEWTEK ELECTRICALS / RISHABH / SCHNEIDER / SECURE / SIEMENS
ANALOG (ELECTROMECHANICAL) METERS – AMMETER & VOLTMETER	AE / IMP / C&S/ MECO / RISHABH / SELEC
HANDHELD DIGITAL MULTIMETER / CLIP-ON METER / MEGGER	FLUKE / IMP / MECO / MOTWANE / RISHABH
CONTROL / SELECTOR SWITCH	ABB / ALSTOM / BCH / EE / GE / HAVELLS / JYOTI KAYCEE / LK-E&A (FORMLY L&T E&A) / RECOM / SCHNEIDER / SIEMENS / SULZER
INDICATING LAMPS	ABB / BCH / EE / IEC / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / TEKNIC CONTROLS / VAISHNO
PUSHBUTTONS	ABB / BCH / LK-E&A (FORMLY L&T E&A) / RASS / SCHNEIDER / SIEMENS / TEKNIC / VAISHNO
CONSTANT VOLTAGE TRANSFORMER/CONTROL TRANSFORMER	AE / ASHMORE / G & M / INDCOIL / NEC / PRAGATI / PRECISE / SILKAANS
MICROPROCESSOR BASED MOTOR PROTECTION RELAY WITH RS 485	ABB / CSPC (C & S) / EXCEL-TECH INDIA / LK-E&A (FORMLY L&T E&A) / PROK DEVICES / SCHNEIDER / SIEMENS / MITSUBISHI
BI-METAL / ELECTRONIC / MICROPROCESSOR BASED OVERLOAD RELAY	ABB / ALSTOM / CSPC (C&S) / CG POWER / GE / INDO ASIAN / LAURITZ KNUDSEN ELECTRICAL & AUTOMATION / SCHNEIDER / SIEMENS / MITSUBISHI
THERMISTER RELAY	ALSTOM / INSTA CONTROLS / MINILEC / SELEC
SINGLE PHASING PREVENTER WITH UV/OV PROTECTION	ABB / C&S / GE / LK-E&A (FORMLY L&T E&A) / MINILEC / SCHNEIDER / SIEMENS

TIME SWITCH	GIC / LEGRAND / SCHNEIDER / SIEMENS / THEBEN
TIMERS / TIME DELAY RELAY	ABB / C&S/ BCH / EAPL / ELICO / INDO ASIAN / LEGRAND / LAURITZ KNUDSEN ELECTRICAL & AUTOMATION / MINILEC / OMRON / PLA / SCHNEIDER / SIEMENS / TEKNIC / THEBEN
PANEL VENTILATION FAN	COOLTRON / HICOOL / NADI / REXNORD
TERMINAL BLOCK/CONNECTORS	CONNECTWELL / ELMEX / PHEONIX / TELEMCHANIQUE / WAGO
LIGHTING / SMALL POWER DISTRIBUTION BOARDS / ENCLOSURES	ABB / BCH / C&S / ELDON / ENCLOTEK / HENSEL / HAVELLS / INDO ASIAN / LEGRAND / LK-E&A (FORMLY L&T E&A) / RITTAL / SCHNEIDER / SIEMENS / STANDARD ELECTRIC / ALL APPROVED VENDORS FOR LT PANEL
PUSH BUTTON STATIONS / JUNCTION BOX (FOR CAST ALUMINIUM ONLY)	BALIGA / BCH / CEAG / EXPROTECTA / EXCEL / FCG FLEXPOR / HANSU / HENSEL / PUSTRON / SCHNEIDER / SIEMENS / SUDHIR
NON METALLIC ENCLOSURES (INCLUDING INDUSTRIAL RECEPTACLES / PB STATION)	BCH / HENSEL / LEGRAND / PUSTRON / RITTAL / SCHNEIDER / SIEMENS / SINTEX
MOTORS (LV)	ABB / BBL / BHEL / CG POWER / KEC / LHP / MARATHON / SIEMENS
CABLES HV - XLPE INSULATED	ASIAN CABLE / CCI / FINOLEX / GLOSTER / HAVELLS / KEI / NICCO / POLYCAB / PRIMECAB (RAVIN CABLES) / RPG CABLES (KEC INTERNATIONAL)/ TORRENT CABLES / UNIVERSAL
CABLES LV - POWER & CONTROL CABLES / EARTHING CABLES	ASIAN CABLE / AVOCAB / CCI / FINOLEX / GLOSTER / HAVELLS / KEI / LAPP / NICCO / POLYCAB / PRIME CAB (RAVIN CABLES)/ RPG CABLES (KEC INTERNATIONAL) / RR KABEL / TORRENT / UNIVERSAL CABLES
WIRES - FLEXIBLES (ALL TYPES)	AVOCAB / ANCHOR / ATLAS / FINOLEX / GLOSTER / HAVELLS / KEI / LK-E&A (FORMLY L&T E&A)/ POLYCAB / RR KABEL / UNIVERSAL
GI / FRP CABLE TRAYS, ANY OTHER FRP ITEMS	DUDHAT INFRA / FIBER TECH COMPOSITE / GLOBE / INDIANA / JACINTH / LEGRAND / KISMAT ENGITECH LLP / M.M. ENGINEERING / SHARDA / SILVERLINE POWER / SHREE KRISHNA ENGG. / SUPER ELECTRO / SUMIP / SATYAM COMPOSITES / VATCO
CABLE TERMINATION/JOINTING KITS	3M / ABB / CCI / KABELDON / M SEAL / RAYCHEM / XICOM
UPVC CONDUIT & ACCESSORIES	AKG / BHAGYALAXMI PIPE INDUSTRY / CLIPSAL / LK-E&A (FORMLY L&T E&A) / POLYCAB / PRECISION / SALZER / ANY OTHER FOR UPVC PIPES AS PER MECHANICAL VENDOR LIST
MS / GI CONDUIT & PIPES	BEC INDUSTRIES / JINDAL / JK TUBE / SAIL / TATA STEEL / ZENITH / ANY OTHER FOR MS/GI PIPES AS PER MECHANICAL VENDOR LIST

HIGH MAST LIGHTING SYSTEM	BAJAJ / CGL / PHILIPS / SURYA / VALMONT
MS / GI LIGHTING POLES & BRACKETS (TUBULAR SWAGED / OCTAGONAL)	AMBICA POLES PVT LTD / BAJAJ / BOMBAY TUBES AND POLES / FABIRON /KISMAT ENGITECH LLP / GAYATRI ELECTRICALS / INDIA ELECTRIC POLES / RIDDHI POLES / SHAKTI POLES / SURYA / SHREE KRISHNA ENGG. / UTKARSH INDIA
LIGHT FIXTURES	BAJAJ / C&S / CGL / GE / HAVELLS /PHILIPS / WIPRO/POLYCAB/PANASONIC
DECORATIVE / MODULAR SWITCH & SOCKET	ABB / ANCHOR / CLIPSAL /HAVELLS / LK-E&A (FORMLY L&T E&A) / LEGRAND / MK-HONEYWELL / SIEMENS / SCHNEIDER
CEILING / WALL MOUNTING / EXHAUST FANS	ATOMBERG / ALMONARD / BAJAJ / CGL / HAVELLS / KHAITAN / ORIENT / USHA
CHEMICAL TYPE EARTHING INCLUDING COPPER BONDED ELECTRODE & BACK FILL COMPOUND	ASHLOK / CURSP / ECO TECHNOLOGY & PROJECTS/ ENNOV INFRA / ERICO / ISG GLOBAL / JEF / PRAGATI ELECTROCOM / SAARA EARTHING
DIESEL ENGINES	ASHOK LEYLAND / BAUDOUIN / CATERPILLAR / CUMMINS / KOEL / MAHINDRA POWEROL / MITSUBISHI / PERKINS / VOLVO / WARTSILA/TATA MOTORS/ STERLING GENERATORS
ALTERNATORS FOR DG SETS	BHEL / CGL / JYOTI / KEC / KOEL / LEROY SOMER / NGEF / STAMFORD
AMF RELAY, SYNCHRONIZING RELAY (WITH RS 485)	C & S / DEEP SEA / DEIF / WOODWARD

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, and final selection will be done with the approval of Engineer-in-charge.

APPROVED VENDORS FOR INSTRUMENTATION SYSTEM

Item Description	Approved Vendors
Process Analyzers (pH, DO, Free/Residual Chlorine, , ORP, Conductivity, TSS, Turbidity, MLSS, BOD/COD, Total Hardness +Ca Hardness + Mg. Hardness Analyzer, Oil in water Analyzer, Color Analyzer, Total Phosphorus Analyzer, Ammonical Nitrogen & TN Analyzer, TKN Analyzer, FRC Analyzer, Sulphide Analyzer, Chloride Analyzer, Phenol Analyzer, Sulphate Analyzer, Phosphate Analyzer, Total Alkanity Analyzer, Free Alkanity Analyzer, Cyanide Analyzer, Total Arsenic Analyzer, Boron Analyzer, Total Chromium Analyzer, Hexavalent Chromium analyzer, Total Copper Analyzer, Total Zink Analyzer, Total Nickel Analyzer, Total Iron Analyzer, Total Aluminium Analyzer, fluoride Analyzer, Manganese Analyzer, SDI,etc.)	E+H, Emerson, Hach, Yokogawa, Xylem / WTW, Krohne, ABB,Horiba,Metrohm, Thermo orion
Laboratory Instrument (Portable / Handheld) - pH / Turbidity / TDS (conductivity meter, Anionic Surfactant, Cadmium, lead, Total Mercury, Tin, Molybdenum, coliform, Silver, Formaldehyde, Phenolic compound, Anionic Detergent), etc.	Hach, Orion, YSI, Radiometer, Denver, Hanna

, ,Ultrasonic Type Level / Diff. Level / Open Channel Flow Transmitter/ Radar Type Level Tx.	Endress+Hauser, Siemens, Krohne, Vega, Emerson, ABB
Hydrostatic type level transmitter	ABB, E+H, Siemens, Krohne Marshall, Emerson
Electro Magnetic Flow Meter	ABB, E+H, Krohne Marshall, Yokogawa, Siemens
Ultrasonic Flow Meter (Insertion / Clamp on type)	ABB, E+H, Krohne Marshall, Siemens
Thermal Mass Flow meter	ABB, E+H, Siemens
Differential Pressure / Pressure / Temperature Transmitter	ABB, Emerson, Fuji, Honeywell, Siemens, E+H Yokogawa
Pressure/Diff. Pressure Switch, DP Gauge	Dag Process Instruments, Danfoss, E+H, Indfoss, N.K. Instruments, Verma Trafog, Orion, Switzer
Pressure / Compound Pressure Gauges	Wika, General Instru. Consortium, Pricol, Manometer (I) P. Ltd., Baumer, Excel Instrument, Precision Mass, Forbes Marshall, H. Guru
Displacer / Float / Buoyancy Level Switch	ATMI, Baumer, E+H, Nivelco, P+F, Pune Techtrol, SBEM, Levcon, Nivo/Toshbro
Float & Board type Level Gauge/ Tubular type Level gauge	Nivo/Toshbro, Pune Techtrol, Revathi, SBEM , Levcon , Jayati Instrumentation, General Instrument Consortium
DCS/ Programmable Logic Controller (PLC) System / HMI/SCADA Software	ABB, Rockwell (Allen Bradley), Schneider, Siemens, Honeywell, Yokogawa
Panel Enclosures	BCH, Bartakke, Eldon (nVent Hoffman), Enklotek, Rittal, Pyrotech
DC Power Supplies (DIN Rail mounted)	Phoenix, Omron, Aplab, IFM, Schneider, Allen Bradley, Siemens, Intex, Microtex, Schneider, IFM, Meanwell
GSM/GPRS Modem	Maestro (Lantronix), Axitech, Netgear, D-link, Moxa, Robustel, Teltonika
Ethernet Switch	D-Link, Rockwell, Siemens, Schneider, Cisco, Phoenix Contact
Media Converter	Digisol, TP link, Microtek D-link, Moxa
Receiver Indicators (Panel Mounted)	Masibus, Nivam, Nishko, Selec , Yokogawa ,Multispan
Miniature Relay	ABB, Omron, Phoenix, Schneider, Rockwell
Indication Pilot Lamps (LED Type)	Teknic, Schneider, Siemens, Salzer, Vaishno
Push Button/ Selector Switch (with NO/NC Element)	Teknic, Schneider, Siemens, Salzer, L&T, Rass, Vaishno, Kaycee, Binay

Fuses	L&T, Siemens, ABB, Schneider, Bussmann
Lightning Protection Unit	Rittmeyer, MTL, Crompton, P+F
Terminals	Elmex, Phoenix, Wago, Connectwell
Panel Wires	Finolex, Havell's, R R Kabel, Lapp Cable, L&T, Polycab
Panel Illumination	Philips, Crompton, GE, Bajaj, Havells, Surya
Hooter	Reputed
Computer System including Monitor / Laptop computer	HP-Compaq, Dell, Acer. IBM – Lenovo, Asus
Anti-virus software	Quick heal, McAfee, Norton
UPS	Emerson (Liebert / Vertiv), Schneider (APC), Merlin Gerin, Socomec, Hirel-Hitchi, Eaton, Numeric, ABB, BPE
LED / LCD TV	Samsung, Sony, Panasonic, LG
Printer (Inkjet/Laser Jet)	HP, Canon, Samsung, Ricoh, Epson
Instrument Cables (Power , Signal, Control)	Associated Cables, Associated Flexible and Wires P.Ltd. Brook Cables, Thermo cables, Udey Pyro, RPG Cables. Polycab, Rolliflex, RR Kabel, Havells, KEI.
Fiber optic cable	Tyco-AMP , Panduit, Systimax, D-link, R & M
Communication Cables	D-Link, Delton, Finolex, Lapp Cable, Molex, Udey Pyro
Junction Box (Metallic / Cast Alu.)	Ex- Protecta, CEAG, Sudhir, Baliga, FCG, VSM Plast, Phoenix Mecano, Hensel
Junction Box / Enclosures (Polycarbonate / ABS or such Polymer)	EPP Composites, Eaton, VSM Plast, Phoenix Mecano, Hensel, Legrand, Sintex
Cable Glands	Ex-Protecta, Braco, Comet, HMI, 3D, Sudhir, Connectwell, Any Reputed
Cable Tray (GI / FRP), Any Other FRP item	M.M.Engineering, Globe, Jacinth, Silver line Power, Shree Krishna Electrical, Sumip, Fiber Tech Composite/ Satyam Composites, Dudhat Infra, Indiana ,Legrand, Sharda , Vatco , Super Electro, Kismat Engitech LLP
Instrument Valves and Manifolds, Tube Fittings, Pneum. Brass Fittings	Excel Hydropneumatic, Industrial Enterprise, Festo, Multimetal Industries, Placka, SMC, Technomatic, Wesmec, Fluid Controls, Aptek , Anmol (Superlok), General, Smart, Instrument Consortium
Solenoid Valves	Asco, Rotex, Schrader, Janatics, Uflow, Avcon, Alcon Alexander, Indfoss, Precision Instruments

Air Conditioners	O General, Hitachi, Panasonic, Voltas, Mitsubishi, Blue Star, Carrier, LG, Samsung, Daikin
Office Furniture	Godrej, Blind Men's Associations, HOF, Equi. reputed
CCTV Camera	Siemens, GE, Honeywell, H.K Vision, Godrej, Zicom, Zebronic, CP Plus, Bosch, Panasonic, Samsung, Canon, Pelco, Smart Guard, Indigo Vision, Dvtel
Control Valves (Pneum. Operated)	ABB, Fisher Xomox, Fouress, Forbes Marshall Arca, MIL Control, Continental Valves, Samson Controls, SPX Valves, Flowserve India Control Pvt. Ltd, Valmet Flow Control Pvt. Ltd. (formerly Neles/ Metso). Bray Controls India Pvt ltd
Pneumatic Actuator	Emerson, Rotex, Schrader, Festo, SMC
I/P Converter	Moore, ABB, Samson, Norgren, Emerson, Yokogawa, Shreyas Instrument, Placka, MTL
Air Filter Regulator (AFR)	ABB, Placka, Shavo Norgren, Festo, Divya Control, Janatics, V. automat, Veljan Hydrair
Smoke Detector	Honeywell, Siemens, Johnson Controls, Robert Bosch Global, Hochiki Corporation,
Smart Card based Access Control System	Godrej, Yale, Dorset, Qubo, IPSA India

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, final selection will be done with the approval of Employer.

NOTE:

1. The final Selection of make from the approved vendor list rests with M/s JPCRF / shall be prerogative of JPCRF and bidder shall commence procurement only after getting required approval for make from JPCRF.
2. In case of Make of any other equipment / item / components not specified in the above list then the approval of make of such items shall be subject to the approval of M/s JPCRF on basis submission of vendor credentials by bidder (Company Profile with financial statement, List of PO executed in Last Five Years from date of LOI , at least 2 nos. performance certificate from end user, etc. shall be submitted by bidder in support of vendor credential for the review and approval by JPCRF).

