

JAWAHARLAL NEHRU NATIONAL URBAN RENEWAL MISSION PROJECT



**CHENNAI METROPOLITAN WATER SUPPLY AND
SEWERAGE BOARD
CHENNAI- 600 002**

NATIONAL COMPETITIVE BIDDING

BID DOCUMENT

FOR

**PROVIDING SEWERAGE FACILITIES TO ULLAGARAM PUZHUTHIVAKKAM
MUNICIPALITY - COLLECTION SYSTEM, CONSTRUCTION OF PUMPING
STATION AND FORCE MAINS IN ZONE-I, II & III**

CONTRACT NO: CNT/SEW/NCB/JNNURM/ 102A /2010-11

BID DOCUMENT

VOLUME - II

SECTION 7 - SPECIFICATIONS

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INTERPRETATION

In this contract the following words shall be understood as having the meanings herein assigned to them.

- a. "The Board" means the Chennai Metropolitan Water supply and Sewerage Board, a Statutory Body constituted under Madras Metropolitan Water Supply and Sewerage Act 1978 having its Office at No. 1, pumping Station Road, Chintadripet, Chennai - 2 and any officer duly authorized by this Board to act on its behalf.
- b. 'Contractor' means the person or persons or firm or company contracting for the work specified, including his or their executors or administrators or legal representatives or successors :
- c. 'Engineer' means Chief Engineer (or) his representative or any other Engineer appointed from time to time by the Board to act as such in connection with these Works. Whenever any Work is specified to be done or material supplied to the satisfaction of the Engineer, it shall be taken as including his properly authorized assistants and duly authorized representatives.
- d. 'Works' means works to be constructed, completed and maintained in accordance with contract.
- e. TNBP - TamilNadu Building Practice.
- f. IS - Indian Standards
- g. ISO - International Organization for Standardization
- h. 'CPHEEO Manual' means 'Manual on Sewerage and Sewage Treatment' published by Central Public Health & Environmental Engineering Organization.

PROJECT DESCRIPTION

This project contemplates Providing Sewerage facilities to Ullagaram Puzhuthivakkam Municipality - Collection System, Construction of Pumping Station and Pumping mains in Zone-I, II & III of Ullagaram Puzhuthivakkam Municipality.

The major components of the scheme are as follows:

1. Providing Collection system for
 - Zone I covering Mc Millan Nagar, Narmada Nagar, Shankar Nagar, MG Nagar, Thomas Nagar, Samy Nagar, Rajeswari Nagar, Union Car bide Colony, Perumal Nagar, Jagathambal Colony, Alwar Nagar, etc for a total length of 19324m using SW pipes of diameter ranging from 150mm to 200mm dia & DI pipes of diameter ranging from 200mm to 400mm dia with 704 manholes for depths ranging from 1m to 7.5m and House service connections
 - Zone II covering Kalaimagal Nagar, Murugappa Nagar, EVR Colony, Ravanan Nagar, Sarathi Nagar, Puzhithivakkam Main Road, part of Madipakkam Main Road, etc for a total length of 14049m using SW pipes of diameter ranging from 150mm to 250mm dia & DI pipes of diameter ranging from 200mm to 450mm dia with 518 manholes for depths ranging from 1m to 5m and House service connections
 - Zone III covering Sheela Nagar, Sadasiva Nagar, Ramakrishna Raj Nagar, Annai Theresa Nagar, Ram Nagar, Sivaprakasam Nagar, Ram Nagar, Bageerathi Nagar, AGS Colony, Srinivasa Nagar, Balaji Nagar, Jayalakshmi Nagar, Jaya Nagar, Usha Nagar, Radha Nagar, Indhu Colony etc for a total length of 34495m using SW pipes of diameter ranging from 150mm to 200mm dia & DI pipes of diameter ranging from 200mm to 600mm dia with 1187 manholes for depths ranging from 1m to 8m and House service connections
2. Construction of Sewage Pumping Stations at the following locations:
 - i. Construction of Sewage Pumping Station in the vacant land at Drowpathi Amman Koil Street to serve Zone I.
 - ii. Construction of Sewage Pumping Station in the vacant land near Ullagaram Eri at Ravanan Nagar 2nd Street to serve Zone II
 - iii. Construction of Sewage Pumping Station in the vacant land near Burial Ground (Adjacent to AGS colony) to serve Zone III.
3. Supplying, conveying and laying Pumping Mains as mentioned below:
 - a. 400mm dia DI Pumping Main from Zone-I SPS to Zone – III SPS for length of 2350m
 - b. 350mm dia DI Pumping Main from Zone-II SPS to Zone – III SPS for length of 1700m
 - c. 700mm dia DI Pumping Main from Zone-III SPS to Perungudi STP for length of 5450m

4. Installation of pumping machineries, allied piping work and electrical work
 - a. Zone – I Sewage Pumping Station at Drowpathi Amman Koil Street
 - b. Zone – II Sewage Pumping Station at Ravanan Nagar 2nd Street
 - c. Zone – III Sewage Pumping Station in the vacant land near Burial Ground (Adjacent to AGS colony)

5. Construction of compound wall at
 - a. Zone – I Sewage Pumping Station at Drowpathi Amman Koil Street
 - b. Zone – I Sewage Pumping Station at Ravanan Nagar 2nd Street
 - c. Zone – III Sewage Pumping Station in the vacant land near Burial Ground (Adjacent to AGS colony)

General : From the sample Boreholes conducted at various locations it is observed that the local lithology is as follows:

0- 4m Brown Clayey silty sand, Grey clayey silty sand

4 – 6m Soft Disintegrated Rock

Above 6m – Hard Rock.

The location and soil test conducted at eight locations is given in the appendix.

CHAPTER 1 - GENERAL

1.1 MATERIALS:

- a. 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.
- b. All materials shall be new and of the kinds and qualities described in the contract and shall be at least equal to approved samples.
- c. 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.

1.2 SAMPLES AND TESTS OF MATERIALS:

- a. The Contractor shall submit samples of such materials as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.
- a. Samples shall be submitted and tests shall be carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.
- b. The Contractor shall give the Engineer minimum fifteen 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 the Engineer. The Engineer or his nominee shall attend the test at the appointed place within fifteen 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 the Engineer to carry out such a test on a mutually agreed upon date in his presence. The Contractor shall in any case submit to the Engineer within seven days of every test such number of certified copies (not exceeding six) of the test readings as the Engineer may require.
- c. Approval by the Engineer for placing orders for materials or for samples or tests shall not prejudice any of the Engineer's powers under the Contract particularly under the provisions of Conditions of Contract.
- d. The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

1.3 STANDARD S:

- a. The special attention of the Contractor is drawn to the relevant sections and clauses of the National Building Code of India (latest revision) and latest I.S. Specifications (latest editions as amended) and should follow all the specifications and conditions strictly.
- b. Materials and workmanship shall comply with the relevant Indian Standards or any other National standards equivalent or higher than Indian standard (with amendments) current on the date of submission of tender only.
- c. Where the relevant standard provides for the furnishing of a certificate to the Employer, at his request, stating that the materials supplied comply in all respects with the standards, the Contractor shall obtain the certificate and forward it to the Engineer.
- d. The specifications, standard and codes listed below are made a part of this specification. All standards, tentative specifications, specifications, code of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.
- e. If no standard is indicated, the relevant Indian Standard, if any, shall apply, Indian standards are published by:

Bureau of Indian Standards
Manak Bhavan,
9, Bahadur Shah Zafar Marg,
NEW DELHI – 110 002.
- f. In case of discrepancy between the specification and the Standards referred to herein, the Specification shall govern.

i) Materials – Applicable Indian Standards:

IS: 455 – 1989	Specification for Portland slag cement
IS: 1489 – 1991	Specification for Portland pozzolana cement
IS: 6909 – 1990	Specification for super sulphated cement
IS: 8041 – 1990	Specification for rapid hardening Portland cement
IS: 8043 – 1991	Specification for hydrophobic Portland cement
IS: 8112 – 1989	Specification for 43 grade ordinary Portland cement
IS: 12269 – 1987	Specification for 53 grade ordinary Portland cement

IS: 383 – 1970	Specification for coarse and fine aggregates from natural sources for concrete.
IS: 432 – 1982	Specification for mild (part I & II) steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 1786 – 1985	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 4990 - 1993	Specification for plywood for concrete shuttering work.
IS: 1726 – 1991	Specification for Cast Iron Manhole Covers and Frames.
IS: 883 – 1994	Code of practice for design of structural timber in building.
IS: 1077 – 1992	Common Burnt Clay Building Bricks – Specification.

ii) Tests

IS: 516 - 1959	Method of test for strength of concrete
IS: 1199 – 1959	Method of sampling and analysis of concrete
IS: 2386 – 1963	Method of test for (Part I & VIII) aggregate for Concrete
IS: 5640 – 1970	Method of test for determining aggregate impact value of soft coarse aggregates
IS: 2720	Methods of test for soils (Parts I & XLI) (latest revisions)
IS: 3025 – 1964	Method for sampling and test (physical and chemical) for water used in construction.

iii) Code of practice

IS: 456 – 2000	Plain and Reinforced concrete – Code of Practice
IS: 800 – 1984	Code of practice for general construction in steel
IS: 2502 – 1963	Code of practice for bending and fixing of bars for concrete reinforcement
IS: 3558 – 1983	Code of practice for use of immersion vibrators for consolidating concrete
IS: 10005 – 1994	SI Units and Recommendations for the use of the Multiples and of certain other units.

	IS: 10262 – 1982	Recommended guidelines for concrete mix design
	IS: 4111 Part 1 – 1986	Manholes (first revision)
	IS: 4111 Part 4 – 1986	Pumping stations and Pumping mains (rising main)
iv)	Construction Safety	
	IS: 3696	Safety code of scaffolds (Parts I & II) and ladders (latest revisions)
	IS: 2750 – 1964	Specification for steel scaffolding
	IS: 3764 – 1992	Code of safety for excavation work
v) Steel	
	IS: 2751 – 1979	Code of practice for welding of M.S. Plain & Deformed Bars for reinforced concrete construction
	IS: 9417 – 1989	Recommendations for welding cold worked steel bars for reinforced concrete construction
	IS: 10790 - 1984	Methods of sampling of steel for prestressed and reinforced concrete part 2 Reinforcing steel.
	IS: 1566 – 1982	Specification for Hard-drawn steel wire fabric concrete reinforcement.
	IS: 280 - 1978	Specification for Mild Steel Wire for General Engineering.
v	i) Brickwork plastering	
	IS: 2116 – 1980	Specification for Sand for masonry mortars.
	IS: 3495 – 1992	Methods of test of Burnt clay Building Bricks. (Part 1 – 4)
vii)	Sanitary Appliances	
	IS: 1726 – 1974	Specification for cast iron manhole covers and frames - Part 1 to 8
	IS: 5455 – 1969	Specification for cast iron steps for Manholes
	IS: 5312 – 1984	Specification for swing check type reflux (non return valves – Part 1 & 2

	vii) Sluice Valves	
	IS: 1364	Hexagon Head Bolts, Screws and Nuts of product Grade A and B (Part 1 – 6 latest revision)
	IS: 638 – 1979	Specification for sheet rubber jointing and rubber insertion jointing.
	IS: 2685 – 1971	Code of practice for selection, installation and maintenance of sluice valves.
	IS: 14846 – 2000	Sluice valve for water works purposes (50 to 1200mm size) – Specification
v	iii) Ductile Iron Pipes	
	IS: 8329 – 2000	Centrifugally cast (spun) Ductile Iron pressure pipes for water, gas and sewage - Specification
	IS: 5382 - 1985	Specification for Rubber sea ling ri ngs for g as mains, water mains and sewers.
	IS: 3400	Methods of test for vulcanized rub bers (Part 1 – 23 - latest revisions)
	IS: 13655 – 1993	Guidelines for Heat Treatment of Cast Iron.
	IS: 1500 – 2005	Methods for brinell hardness test for metallic materials.
	IS: 9523 – 2000	Ductile Iron fittings for pressure pipes for Water, Gas & Sewage – Specification.
	IS: 12288 – 1987	Code of practice for use and la ying of Du ctile Iron Pipes.
	IS: 2062 – 1999	Steel for General Structural purposes – Specification.
	ix) SW Pipes	
	IS: 651 - 1980	Salt glazed stoneware pipes and fittings (fourth revision)
	IS: 4127 - 1983	Code of practice for la ying g la zed Stoneware P ipes (First revision).
	x) Manuals	
	TamilNadu Building Practice	
	Manual on Sewerage and Sewage Treatment published by CPHEEO	

1.4 SPECIAL CONDITIONS

1.4.1 CONSTRUCTION WATER:

The Contractor shall make his own arrangement for the fresh water required for construction of civil works and testing of pipeline and hydraulic structures as well as for the potable water required for his labour camps.

1.4.2 CONSTRUCTION POWER:

The Contractor shall make his own arrangement for supply of electrical energy required at his sites and the works.

1.4.3 TEMPORARY FENCING:

The Contractor shall, at his own expense, erect and maintain in good condition temporary fences and gates along the boundaries of the areas assigned, if any, to him by the employer for the purpose of the execution of the works.

The Contractor shall, except when authorised by the Engineer, confine his men, materials and plant within the site of which he is given possession. The Contractor shall not use any part of the site for purposes not connected with the works unless prior written consent of the Engineer has been obtained. Access shall be made to such areas only by way of approved gateways.

1.4.4 SANITARY FACILITIES:

The Contractor shall provide and maintain in clean and sanitary condition adequate W.C.'s and wash places, which may be required on the various parts of the site or use of his employees, to the satisfaction of the Engineer. The Contractor shall make all arrangements for the disposal of sewage or drainage in accordance with the directions of the Engineer.

1.4.5 RESTRICTED ENTRY TO SITE:

The Contractor shall get the prior permission of the Engineer before any person not directly connected with the works to visit the site.

1.4.6 EXISTING SERVICES:

Drains, pipes, cables, overhead electric wires and similar services encountered in the course of the works shall be guarded from injury by the Contractor at his own cost, so that they may continue in full and uninterrupted use to the satisfaction of the Employer and the Contractor shall not store materials or otherwise occupy any part of the 'site' in a manner likely to hinder the operation of such services. The Contractor must make good or bear the cost of making good, the damage done by him on any mains, pipes, cables or lines (whether above or below ground), whether shown or not shown in the drawings, without delay to the satisfaction of the Engineer and the Employer.

1.4.7 ELECTRIC POWER SUPPLY:

1. The Electrical Power required has to be obtained by the Contractor from the Tamil Nadu Electricity Board.
2. The Contractor is forewarned that there can be interruptions in power supply for reasons beyond the control of the Tamil Nadu Electricity Board and therefore the contractor is advised to make his standby arrangement to provide and maintain all essential power supply for his work area at his expense. The contractor shall not be entitled to any compensation for any loss or damage to his machinery or any equipment or any consequential loss in progress of work and idle labour as a result of any interruptions in Power supply.

1.4.8 NOTICE TO TELEPHONE, RAILWAYS & ELECTRICITY SUPPLY UNDERTAKING:

Before commencing operations the contractor has to obtain permission from local bodies / Highways Department when he wants to cut any section of the road. The employer will give necessary assistance such as sending letters and attending meetings if required. The employer will also pay necessary charges towards restoration of roads to the Corporation of Chennai / State Highways and National Highways. Any delay in getting the permission from the Corporation / Panchayats / Municipalities, State Highways Department, National Highways Department, Railway Department, Electricity Board, Telegraphs Department, Traffic Department attached to the police and other departments or companies for carrying out the work will be to the account of contractor.

The contractor before taking up operations, which involve cutting of roads, shifting utilities etc., during the progress of the work, shall give notice to the concerned authorities viz. the Corporation / Panchayats / Municipalities, State Highways

Department, National Highways Department, Railway Department, Electricity Board, Telegraphs Department, Traffic Department attached to the police and other departments or companies as may be affected by the work. The notice should identify the specific details so that the necessary diversion of traffic may be arranged and permissions obtained. The contractor shall co-operate with the department concerned and provide for necessary barricading of roads, protection to existing underground cables etc., met with during the excavation of trenches. The contractor shall provide at his own expenses watching and lighting arrangements during day and night and erect required notice board such as "Caution Road closed for Traffic" etc.,. He should also provide and maintain at his own cost the necessary supports for underground cables etc., to afford best protection to them in consultation with the authorities in charge of the properties and to their best satisfaction. The contractor has to make necessary arrangements to get supply of electricity from TNEB for operating the machinery and equipments. The employer will pay the necessary service connection and S.D charges. The contractor should obtain all approvals for installation and commissioning of machinery and accessories offered by them from the respective inspecting authorities such as CEIG or CEFG etc., Fees if any, to be paid to the inspecting authorities will be reimbursed by the Employer.

1.4.9 PERMISSION FOR ROAD CUTS:

Wherever the Contractor considers that it is necessary to cut through an existing road or track he shall submit details to the Engineer for approval, a minimum of seven days before such work commences.

In the event of cutting a road by the Contractor without the written permission from the Engineer, the Contractor shall be responsible for the cost of reinstating the road as undertaken by the Municipal Road Department or the Highways Department, as the case may be, notwithstanding the general procedures included in Chapter 5, Earthwork. Where all permissions are correctly obtained the cost of such reinstatement will be paid directly by the employer.

1.4.10 TEMPORARY DIVERSION OF ROADS:

During the execution of the work the Contractor shall make at his cost all necessary provision for the temporary diversion of roads, cart-tracks, footpaths, drains, water courses, channels etc., if he fail to do so, the same shall be done by the Engineer and the cost thereof will be recovered from the Contractor.

1.4.11 BARRICADING:

The manhole / trench shall be barricaded on all four sides. The Contractor who has dug up the trench shall be responsible for any mishap, which may occur. Non-barricading of trenches by the Contractor shall be liable for a fine of Rs.500/- per day, per location from the interim payment certificates prepared in accordance with Sub Clause 60.2 in Section 4 Conditions of Contract for the particular application. Such deduction will not relieve the Contractor of any liability or duty under the Contract.

1.4.12 FILLING IN HOLES AND TRENCHES ETC.:

The Contractor immediately upon completion of the Works shall fill up holes and trenches which may have been made or dug, level the mounds, or heaps of earth that may have been raised or made, and clear away all rubbish which may have become superfluous or have been occasioned or made in the execution of the works, and the Contractor shall bear and pay all costs, charges etc.

1.4.13 ACCIDENTS:

It shall be the duty of the Contractor to arrange for the execution of the works in such a manner as to avoid the possibility of the accidents to persons or damage to the properties at any state of the progress of work. Nevertheless he shall be held wholly responsible for any injury or damage to persons and properties, which may occur irrespective of any precautions he may take during the execution of the works. The Contractor shall make good all claims and loss arising out of such accidents and indemnify the Employer from all such claims and expenses on account thereof.

1.4.14 WATER AND LIGHTING:

The Contractor shall pay all fees and provide water and light as required from Municipal mains or other sources and shall pay all charges, thereof (including storage tanks, meters etc.) for the use of the works and workmen, unless otherwise arranged and decided on by writing with Engineer. The water used for the works shall be free from earthy vegetable or organic matter and from salts or other substances likely to interfere with the setting of mortar or otherwise prove harmful to the work and conform to relevant standards.

1.4.15 PAYMENT TO LABOURERS:

The Contractor should note, that in the event of emergency, he shall pay all labourers every day. The Contractor shall not employ any labourer below age of 15 years.

1.4.16 EQUIVALENCE OF STANDARDS AND CODES:

Whenever reference is made in the contract to the respective standards and codes in accordance with which plant, equipment or materials are to be furnished and work is to be performed or tested the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly set forth in the contract. Where such standards and codes are national in character, or relate to a particular country or region, other authoritative standards which ensure equal or higher quality than the standards and codes specified will be accepted subject to the prior review and written approval by the Engineer. Difference between the standards specified and the proposed authoritative standards must be fully described in writing by the Contractor and submitted to the Engineer well in advance for approval. If on the prior review, the Engineer determines that such proposed deviations do not ensure equal or higher quality; the Contractor shall comply with the standards set forth in the contract documents.

The Contractor should use only accepted makes of materials and plant and should construct the entire Works according to Specifications, Standards, data sheets, drawings etc. If no makes are specified then only manufacturers of Plant and materials corresponding to the state of the Art technology and / or confirming to the latest Indian / International standards shall be used. Providing materials of approved quality and confirming to the standards does not relieve the Contractor from being responsible for the successful performance of all system components.

1.4.17 SAFETY PROVISION:

1.4.17.1 General Requirements for Health and Safety:

The safety provision shall be brought to the notice of all concerned by displaying on a notice board at a prominent place at the work spot, persons responsible for ensuring compliance with the safety provision shall be named therein by the Contractor.

To ensure effective enforcement of the rules and regulations relating to safety precautions, arrangements made by the Contractor shall be open to inspection by the Engineer or his representative and the inspecting officer.

Notwithstanding the above provision Contractor is not exempted from the operation of any other Act or rules in force relating to safety provisions.

1.4.17.2 Protection of the Public:

No material on any of the sites shall be so stocked or placed as to cause danger or inconvenience to any person or to the public. The Contractor shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of defense of every suit, action or proceedings of law that may be brought by any person for injury sustaining, owing to neglect the above precautions and to any such suit, action or proceedings to any such person or which may with the consent of the Contractor be paid to compromise any claim by any such person.

1.4.17.3 Scaffolding and Ladders:

The Contractor shall ensure that suitable scaffolds are being provided for workers for all the works, which cannot safely be done from the ground or from solid construction, except such short period work, as can be done safely from ladders.

When a ladder is used, an extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than $\frac{1}{4}$ to 1 ($\frac{1}{4}$ horizontal to 1 vertical). IS code for scaffolding and ladders, IS: 3696 Part – I and Part II and its latest revision is to be followed. Every ladder shall be securely fixed. No portable single ladder shall be over 7m in length. Width between side rails in rung ladders shall in no case be less than 30cm. for ladders; this width shall be increased by atleast 6mm for each additional 30cm length. Uniform steps spacing shall not exceed 30cm.

Scaffolding or staging more than 3.25 metres above the ground or floor swung or suspended from an overhead support or erection with stationary support shall have guard rail properly attached bolted, braced or otherwise secured atleast at 1 metre high above the floor or platform and the scaffolding of staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or the structure.

All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in a safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

1.4.17.4 Working Platforms:

Working platform, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if height of a platform or gangways or stairway is more than 3.25 meters above ground level, it shall be closely boarded having adequate width and be suitably fenced as described in 1.4.17.3 above. Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or railing with a minimum height of 1 meter. Safe means of access shall be provided to all working platforms and other working places.

1.4.17.5 Precautions when using Electrical Equipment's:

Adequate precautions shall be taken to prevent danger from electrical equipment. When workers are employed on electrical installations, which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots, as may be necessary shall be provided. Workers shall not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.

1.4.18 D DEMOLITION:

Before commencing any demolition work and also during the process of the work, safety code for demolition of building IS: 4130 of the latest revision shall be followed:

- a. All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- b. No electric cable or apparatus, which is liable to be a source of danger for a cable or apparatus used by operator, shall remain electrically charged.
- c. All practical steps shall be taken to prevent danger to persons employed from risk or fire or explosion or flooding. No floor, roof or other part of a building shall be so overloaded with debris or materials as to render it unsafe.

1.4.19 SA FETY EQUIPMENT:

1.4.19.1 General Requirements:

All necessary personal safety equipment as considered adequate by the Engineer shall be available for use of persons employed on the site and maintained in a condition suitable for immediate use and the Contractor shall take adequate steps to ensure proper use of equipment by those concerned.

- a. Workers employed on mixing asphaltic materials, cement and lime mortars / concrete shall be provided with protective footwear, hand gloves and goggles
- b. Those engaged in handling any materials which is injurious to eyes shall be provided with protective goggles
- c. Stone breakers shall be provided with protective goggles and protective clothing
- d. When workers are employed in confined spaces (sewers, manholes etc.), which are in use, the Contractor shall ensure that manhole covers are opened and manholes are ventilated at least for an hour before workers are allowed to get into them. Manholes so opened shall be cordoned-off with suitable railing and warning signals or boards provided to prevent accident to public. Before entry by any worker the Contractor shall ensure that a gas detector is lowered into the confined space and the atmosphere is shown to be safe.
- e. The Contractor shall not employ men below the age of 15 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting the following precautions shall be taken:
 - i) No paint containing lead or lead products shall be used except in the form of paste of ready-made paint.
 - ii) Suitable face masks shall be supplied for use by workers when paint is applied in the form of spray or a surface having lead paints dry rubbed and scaped.
 - iii) Contractor shall supply overalls to workmen and adequate facilities shall be provided to enable working painters to wash during and on cessation of working periods.

1.4.19.2 Working near water:

When the work is done near any place where there is risk of drowning, all necessary equipment shall be provided and kept ready for use and all necessary steps

taken for prompt rescue of any person in danger and adequate provisions made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

1.4.19.3 Hoisting Machines:

Use of hoisting machines and tacks including their attachments, anchorage and supports shall conform to the following:

- a)
 - i) These shall be of good mechanical construction, sound material and adequate strength and free from patent defects and shall be kept in good repair and in good working order.
 - ii) Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent defects.
- b) Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in-charge of an hoisting machine, including any scaffold winch or giving signals to operator.
- c) In case of every hoisting machine and of every chain ring hook, shackle, swivel and pulley block used in hoisting machine or lowering or as means of suspension, safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with safe working load in case of hoisting with safe working load. In case of hoisting machine having a variable safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond safe working load except for the purpose to testing.
- d) Engineer shall notify the safe working load of the machine in case of departmental machine. As regards Contractor's machine, the Contractor shall notify safe working load of each machine to the Engineer. Whenever he brings to the site of work and get it verified by the Engineer.

Motors, gearing, transmission, electrical wiring and other dangerous parts or hoisting appliance shall be provided with such means so as to reduce to the minimum risk and accident descend of load; adequate precautions shall be taken to reduce to the minimum risk of any part of a suspended load becoming accidentally displaced.

1.4.20 WORKING WITH EXPLOSIVES:

The Contractor shall obtain prior permission of the competent authority such as Chief of Fire services for the site, manner and method of storing explosives near the site of work. All handling of explosives including storage, transport shall be carried out under the rules approved by the “Explosive Department of the Government”.

1.4.21 ENVIRONMENTAL PROTECTION WORK:

The Contractor have to take following measures during construction and commissioning of works for protection of environment as to avoid environmental impacts on air, water and land.

1.4.21.1 Site Clearance:

The site clearance shall be done with minimum damage to existing structures flora and fauna, electricity and telephone lines and other infrastructure service.

1.4.21.2 Earthwork and Excavation:

The Contractor shall inform the local authorities / government if any fossils, coins artifacts of value or antiquity, structures and other remains of geological or archaeological interests and excavation shall be stopped until identification of cultural relics by the authorised institution is complete.

The Contractor shall dispose off surplus / waste material at identified sites approved by the Engineer. The Contractor shall ensure that there is minimum hindrance to normal activities and business. The Contractor shall avoid damage to permanent structures and shall avoid loss of standing crops along the road.

1.4.21.3 Replanting of Trees and Bushes:

The Contractor shall carry out replantation on areas / on the periphery of construction sites to minimize visual impact and soil erosion. The Contractor shall pay special attention to the type of trees to be replanted to prevent fouling of water through falling leaves and bird droppings. A list showing the type of trees to be replanted shall be submitted to the Engineer for approval prior for undertaking any replantation.

1.4.21.4 Soil Erosion and Water Quality:

The Contractor shall ensure that earth and stone do not silt up existing irrigation / drainage systems. The Contractor shall take suitable measures to prevent direct discharge of polluted waters from construction activity into lakes / rivers / irrigation channels.

The Contractor shall minimize exposure of soil types susceptible to wind and water erosion. The Contractor shall control run-off and erosion through proper drainage channels and structures.

1.4.21.5 Soil Compaction:

The Contractor shall restrict traffic movements and use low ground pressure machines. The Contractor shall preserve topsoil to be replaced after completion of construction activity. The Contractor shall avoid wet soils as far as possible.

1.4.21.6 Social Disruption:

The Contractor shall minimize interruptions to utility services through proper planning and scheduling of activities. The Contractor shall provide temporary roads and diversions as may be necessary for smooth flow of traffic and people.

1.4.21.7 Dust / Air Pollution:

The Contractor shall provide effective dust control through sprinkling / washing of construction sites and access roads. The Contractor shall cover / water stockpiles and storage areas to prevent dust pollution. The Contractor shall cover trucks transporting construction materials to minimize spills. The Contractor shall have a preventive maintenance programme for construction equipment and vehicles to meet emission standards. Oil shall not be used to control dust.

1.4.21.8 Noise Pollution:

The Contractor shall normally undertake construction work during daytime only (between 7.30 to 18.00 hrs.) and when authorised to work beyond these hours adopt suitable noise control methods during such works. The Contractor shall maintain machines and trucks to keep them with low noise. The Contractor shall install sound barriers and plant trees as appropriate during construction. The Contractor shall monitor the level of noise near the construction site, factory sites and sensitive areas with the following frequency.

- a) During construction period: 12 times a year each time including day and night.
- b) During commissioning period: 4 times ad hoc monitoring

1.4.21.9 Construction Camps:

The Contractor shall take adequate measures such as provision of septic tank / pit latrines at a construction site / camps. The Contractor shall provide crèche to working women labour. The Contractor shall provide drinking water conforming to IS: 10500 – 1991.

The Contractor shall provide garbage can at suitable fixed place and the garbage shall be disposed off regularly.

1.4.21.10 Aesthetic Improvement:

The Contractor shall through proper house keeping enhance aesthetic appearance of construction sites. The Contractor shall dispose-off construction wastes at approved disposal sites. The Contractor shall repair pavements immediately following construction of pipeline and appurtenant structures.

The Contractor shall remove after completion of construction, all temporary structures and restore the project and surrounding areas nearest possible to the reconstruction condition.

1.4.21.11 Conservation of Ecological Resources:

The Contractor shall not use farmland and forest belts as materials borrow sites. The Contractor shall not select arable land as material borrow site. In case excavation in arable land is unavoidable, topsoil layer (30cms depth) shall be saved and returned after construction work is completed so as to minimize impacts on ecosystem, agriculture and animal husbandry. The Contractor shall educate construction workers to protect natural resources, wild plants and animals.

1.4.22 Use of Trade Names:

Wherever reference is made in the contract to specific manufacturers or trade names the Contractor shall be entitled to substitute Plant and materials supplied by other manufacturers or producers. Such substitution shall be to the approvals of the Engineer, which will not be unreasonably withheld. At the request of the Engineer the Contractor shall provide information to establish that the substituted Plant and materials are equivalent or better than those referred to.

1.4.23 Direction by the Engineer:

The Contractor is responsible for all activities relating to the construction of the works. Any reference in this Specification to the Engineer directing or ordering, prescribing etc. the Contractor shall be deemed to mean “Contractor to propose a methodology of construction and to submit to the Engineer for approval”. Any such approval by the Engineer shall not limit the Contractor’s responsibilities relating to construction of the Works. Notwithstanding this clause the Engineer shall be entitled to instruct the Contractor whenever the Engineer considers it necessary to do so. Where such an instruction is considered by the Contractor to represent additional work he shall inform the Engineer of his opinion before undertaking the work. No claim for additional work on the basis of an instruction by the Engineer can be considered where the Contractor has failed to provide such prior notification.

1.4.24 Definition of the Engineer:

Any reference in the Contract Documents to the Engineer in charge, or Board Engineer, or Executive Engineer, or departmental officers, shall be taken to mean the Engineer.

CHAPTER 2 - SUBMITTALS

2.1 D DESCRIPTION:

This section covers additional requirements for submission of schedules, samples, certificates, etc., and forms a part of all other sections in which submittals are required. It is subjected to General Conditions of Contract.

Requirements of submissions to be included:

1. PERT / CPM Progress Schedule
2. Samples of all materials pertaining to this work
3. Material lists and equipment
4. Factory test reports
5. Certificates
6. Laboratory test reports

2.2 R REQUIREMENTS:

CPM Progress Schedule:

Within 30 days of award of the tender, the Contractor shall submit a critical path method analysis for construction progress control and make such revisions as are required for approval. He shall clearly indicate all construction activities, sub activities and mileposts on a time-oriented basis, with the critical path fully identified for all activities. He shall update and resubmit the charts monthly, flag all slippages and mileposts and attach a narrative description of the proposed corrective actions to the resubmitted charts. The Contractor shall include the following minimum information for each activity and critical path item:

- i. Date and initial submittal, as applicable.
- ii. Ordering dates for long lead time items.
- iii. Dates for materials on site.
- iv. Testing and clean up.
- v. Final completion and handing over.

2.3 SAMPLES:

The Contractor has to submit samples of all materials used for the work prior to start of the works and get the approval of the Engineer in charge. He shall label or tag

each sample or set of samples, identifying the manufacturer's name and address, brand name, catalogue number, project title he intends use.

2.4 MATERIAL LISTS AND EQUIPMENT DATA:

The Contractor has to submit all material lists, equipment lists etc. well in advance before starting the work and get the approval of the Engineer in charge.

CHAPTER 3 - SITE PREPARATION

3.1 CLEARING SITE:

Preliminary work are required to be done before laying of pipes including pegging out, clearing and disposal of shrubs, grasses, bushes, hedges, boulders, debris from the route.

This shall also include the removal of stumps, etc. or parts thereof lying along the alignment of pipe. The Contractor should inform the Engineer in charge before removing shrubs, grasses, etc. well in advance. The alignment of the mains shall be so fixed as to avoid cutting of any trees.

3.2 REMOVAL OF TOP SOIL, SHRUBS AND OTHER VEGETATION:

All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material upto a depth of 30cm between ground level/road levels shall be removed. All debris and unsuitable material shall be carted away from the site as per the direction of Board Engineer up to a distance of 10 kms.

3.3 UTILITIES PROTECTION:

All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations. Relocation wherever necessary will be done by the respective Service Departments on payment by CMWSSB separately. No extra payment will be made for minor relocation, which does not require dislocation from existing condition and shifting to other location. In such a condition, the service lines shall be pushed slightly to facilitate laying of main and brought back to original position after the work is completed wherever necessary. The service lines should be supported at bottom with planks, posts, etc. and tied with ropes properly. Any damage to any utility resulting from the Contractor's operations shall be repaired at the Contractor's expense.

3.4 PAVEMENT REMOVAL:

The Contractor must inform the other concerned departments well in advance before starting the work. The Contractor must provide and maintain proper and efficient traffic control system such as safety lamps, sign boards etc. operating day and night for

the full duration of work. The CMWSSB shall not be responsible under any circumstances for any mishappenings therefore. For the purpose of payment for removal of pavement, steel tapes are to be used and the Engineer's representative and Contractor or his representative shall take the measurement jointly. The width of trenches shall be as per the specification drawing and only such widths shall be taken into account for computing quantities for payment. The Contractor has to pay restoration charges for width excavated in excess of prescribed width. For other elements of work such as making cross connections, fixing other appurtenances etc. the Engineer shall prescribe the dimensions for removal of pavement from time to time.

3.5 MAINTENANCE OF TRAFFIC AND CLOSING OF STREETS:

The work shall be carried out in such a manner, which will cause the least interruption to traffic, and road / street may be closed in such a manner that it causes the least interruption to traffic. Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

3.6 INTERRUPTION TO SERVICE:

No valve or other control of the existing services shall be operated without the permission of the authority.

3.7 WORK DURING NIGHTS:

No extra payment will be made for doing the work in the nights. The Contractor shall get prior approval from the Engineer in charge before starting the work during nights.

CHAPTER 4 - DISMANTLING

4.1 DISMANTLING OF EXISTING STRUCTURES:

The structure shall be dismantled carefully and materials removed without causing damage to the serviceable material to be salvaged, the part of the structure to be retained and any properties of structures nearby. Any avoidable damage to the articles to be salvaged and part of the structure shall be made good by the Contractor without extra claims. The Contractor shall be responsible for any injury to the lookers or the public.

Structure should be removed 45cm below Ground and portion which in any way comes within new construction shall be removed entirely. Contractor shall maintain register of the salvaged material, which shall have signature of the Engineer on entries made.

All the material obtained from the removed structures shall be the property of client. Serviceable materials shall be stacked neatly in such a manner as to avoid deterioration at site or at other places. Non-serviceable materials shall be disposed off by the Contractor without causing any inconvenience.

All rubbish shall be cleared off the site and the Ground level clean and clear and Rubbish and non-serviceable materials shall be carted away upto a distance of 10kms as per the direction of Board Engineer.

4.2 MEASUREMENT AND PAYMENT:

The measurements of work shall be exact length and width and height of the dismantled structure. It shall be priced per unit of the Cubic metre. Any excavation that may be necessary for dismantling the structure below 45cm from ground level shall be paid under the item of Excavation and shall include labour for refilling, watering and ramming, spreading on site if required and for disposal of surplus earth.

CHAPTER 5 - EARTH WORK

5.1 DESCRIPTION:

The work specified in this section includes the provision of all labour, machinery, construction equipment and other appliances required to perform all earthwork specified or required, in a sound, workmanlike manner.

5.2 GENERAL:

Excavation shall be required to be done for the following works:

- a) Excavation for underground pipelines.
- b) Excavations for valve chambers, Thrust blocks and Special structure
- c) Excavation for pump rooms.

No separate payments shall be made for removal of shrubs, which are less than 100mm in diameter at breast height, grass, small bushes and stumps. The alignment of the main shall be so fixed as to avoid cutting of any trees.

No extra payment shall be made to the Contractor for working in a confined space.

5.3 CLASSIFICATION:

The excavation work shall be classified into the following categories by inspection of faces of cutting:

- i) Loamy, clayey soils like black cotton soils, red earth, hard gravel, mixture of gravel and soft disintegrated rock like shale, ordinary gravel, stony earth and earth mixed with fair sized boulders, except rock requiring blasting, chiseling, wedging etc.
- ii) Hard rock and boulders to be removed by benching, chipping, chiseling, wedging, barring and by controlled blasting wherever permissible.

5.4 TRENCH EXCAVATION:

General:

Trench excavation means excavation of trenches into which the pipe is to be laid. Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels and the alignment shall be agreed with the Engineer in charge. The Contractor shall dig probing pits of appropriate size and depth including cutting the road at every 100m interval or as directed by Engineer in charge.

The quantity of excavation beyond the normal dimensions will be paid under relevant items of excavations in various strata.

Stripping Surface Materials:

Before the surface of any part of the site is disturbed or the works thereon are started, the Contractor shall take and record levels in the presence of the Engineer or his representative. Before commencing the excavation, the surface materials shall be carefully stripped and set aside for reuse as directed by the Engineer.

5.5 WIDTH OF TRENCH:

The minimum width of the trench at bottom between the faces of sheeting shall be No minimal diameter of the pipe plus 200mm clearance on either side of the pipe. Trenches shall be of such extra width for higher depths, when required as will permit the convenient placing of timber supports, strutting and planking and handling of specials.

The width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches shall be widened at sockets and other structures as may be found necessary. Payment for excavation shall be made on quantity basis as per width given in the Table.

Care should be taken to avoid excessive trench width and thereby increasing the load on the pipes.

5.6 DEPTH OF EXCAVATION OF TRENCHES:

The depths for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of bedding is to be placed below the pipeline, the depth to the bottom of the bedding will be paid.

The trench shall be so dug that the pipeline may be laid to the required gradient and to the required depth, mentioned in the Table below. A minimum cover of 0.8m is to be provided above the crown level of pipe upto the Ground level / Road level.

TABLE SHOWING DETAILS OF TRENCH SIZE

Diameter (mm)	Trench width (m) (Minimum)
100 0	.50
150 0	.55
200 0	.60
250 0	.85

300 0	.70
350 0	.75
400 0	.80
450 0	.85
500 0	.90
600 0	.95
700 1	.00
750 1	.05
800 1	.10
900 1	.20
1000 1	.30

5.7 MAXIMUM LENGTH OF OPEN TRENCH:

Except by special permission of the Engineer, only that length of trench excavation shall be permitted in advance of the pipe jointing, such that laying and jointing of pipes can reasonably be expected to be completed and the trench refilled not later than 3 days after excavation of the trench. The Contractor will not be permitted to keep trenches open for unduly long periods, creating public hazards. The Engineer's decision in this respect shall be final.

5.8 WIDENING TRENCH AT JOINTS, ETC.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the Contractor, after taking all the necessary safety measures.

5.9 OVER-EXCAVATION OF TRENCH BOTTOMS:

All excavation carried below the grades shown on drawings or bottom of the bedding shall be refilled with sand / concrete at the Contractor's expense.

5.10 EXCAVATED MATERIAL:

The material from the excavation shall be deposited on either side of the trench leaving clear berm on one side at least 40cm wide or at such further distance from the edges of the trench as may be necessary to prevent the weight of materials from causing

the side of the trench to slip or fall, or at such a distance and such a manner as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the Engineer may direct, till it is carted away.

The excavated soil should be so placed and handled as not to inconvenience the usual traffic, till it is carted away. The Contractor should also provide necessary bridging over the excavated trenches for the house-holders and pedestrians to cross over and vehicular crossings if and where required at no extra cost; if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect. The Contractor shall be responsible for making all arrangements for the disposal of surplus excavated material upto a distance of 10kms.

5.11 PIPE BEDDING:

i) Sand Bedding:

Where specified, the river sand bedding for the required thickness and level shall be provided below pipe prior to laying the pipe in trenches. It shall be compacted with a light hand hammer. Any reduction in compaction shall be made up by adding sand during ramming. For the purpose of bedding under this item, only screened fine sand of grain size not larger than 2mm shall be used. The sand shall be clean, uncoated and free from clay lumps, injurious amount of dust, soft particles, organic matter, loam or other deleterious substances.

If the sand supplied is unclean, it shall be washed. In no case shall sand containing more than 3.5% by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt in sand and organic impurities described in IS : 383 shall apply. Sieved and washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particle of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the Contractor.

i) Concrete Bedding:

This type of bedding is as per the drawing appended with the tender document and is to be provided at locations shown in the drawings or as specified by the Engineer. Concrete bedding using M10 grade is to be adopted. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

5.12 EXCAVATION FOR APPURTENANCES:

Excavation in trenches for foundation of valve chambers, pedestals, pump room etc. shall be as per the plan or as directed by the Engineer. The dimensions of the excavation shall be measured as the projection in plan of the outermost edges of the structure.

5.13 KEEP EXCAVATION CLEAR OF WATER:

Where ground water is encountered or anticipated, the Contractor shall provide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standby pumping units are to be made available and employed in the event of mechanical failure. The Contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times.

5.14 DEWATERING IN AREAS OF HIGH WATER TABLE:

The Contractor shall perform dewatering as required so that all works of the contract are installed on dry areas and excavations, including without limitation the construction of all structures and underground piping. The Contractor shall ensure that dewatering is carried out only to a depth sufficient for the required excavation. The Contractor shall also ensure that, at all times, during construction, no groundwater shall come into contact with any concrete surface or reinforcement and that any structure shall be capable of withstanding any hydrostatic pressure to which it may be subjected during construction and until completed.

The Contractor shall be deemed to have included in the tender price for maintaining all works in a dry condition during construction. Any water removed from excavations shall wherever practicable, be pumped directly to the natural drainage channel or to storm sewers if approved via an efficient system of discharge lines. No water may be discharged into the sewerage system or onto open spaces.

The Contractor shall include for the diversion of all water courses encountered in the work until the scheme is completed and put into operation.

Notwithstanding any previous approval, the Contractor shall be fully responsible for maintaining dry excavations.

Where deemed necessary by the Engineer, working drawings and data shall be submitted for review or approval showing the intended plan for dewatering operations. Details of locations and capacities of dewatering wells, well points, pumps, sumps,

collection and discharge lines, standby units, water disposal methods, monitoring and settlement shall be included. These shall be submitted not less than 30 days prior to start of dewatering operations.

The static water level shall be drawn down to a minimum of 300mm below the bottom of the excavation so as to maintain the undisturbed state of the foundation soils and allow the placement of any fill or backfill to the required density. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property.

5.15 UNSOUND FOUNDATIONS, SOFT SPOTS:

When the specified levels of trench or structure are reached, the Engineer will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable, he may direct the Contractor to excavate further and the further excavation shall be filled with concrete M-10 or river sand. Should the bottom of any trench or structure excavation, while acceptable to the Engineer at the time of his inspection subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddled, soft or loose during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. In this case, the cost of the extra excavation and of the additional foundation materials required will be the Contractor's responsibility if necessitated by his negligence.

The omission by the Engineer to give an instruction under this Clause shall not relieve the Contractor from any responsibility for defect in the works due to the construction being placed upon an unsuitable formation if prior to the construction of the work the Contractor shall have failed to call the attention of the Engineer thereto in writing.

If in the opinion of the Engineer, a formation is unsound as a result of the Contractor failing to keep the excavation free from water, the Engineer will order the removal and disposal of the unsound material and filling of the resulting void. The Contractor shall execute the work as directed and shall have no claim against the Board for any costs thus incurred.

5.16 CAUTION CUM INFORMATION BOARDS:

Before commencing an excavation, "Caution-Cum-Information" board shall be installed at site by the Contractor. Such board shall remain at site as long as the trench remains open. The board shall be installed at both the ends of the trench at least 100m before the approach to the area, if the trench is less than 600m in length. Additional boards at every 300m shall be installed, if the length of the trench exceeds 600m. If the streetlight is inadequate, lettering with fluorescent paint shall be used for these boards. The boards shall also contain information regarding dates of commencement and completion of the work, name and phone number of the Engineer in charge of the work. See also Clause 5.19. The size of lettering shall be adequate to be read by passing vehicles.

5.17 BARRICADING:

To prevent persons from injury and to avoid damage to the property, adequate barricades, construction sign, torches, red lanterns and guards as required shall be provided and maintained during the progress of the construction work and until it is safe for traffic to use the roadways. The manhole trench shall be barricaded on all four sides. Barricading for laying pipe lines consists of fixing casuarina posts 8 - 10 cm dia. and 1.52m high at 1.53m centre to centre tied with coir ropes in two rows or by any other method as approved by the Engineer. Barricade also includes watching during night, fixing danger flags, danger lights / reflector and painting in different colours. The Contractor who has dug up the trench shall be responsible for any mishap, which may occur.

5.18 FENCING, WATCHING, LIGHTING:

The parts of the fencing shall be of timber, securely fixed in the ground not more than 2.50m apart, they shall not be less than 10cm in dia. or not less than 1.25m above the surface of the ground. There shall be no two rails, one near the top of the posts and the other about 0.50m above the ground and each shall be of 5cm to 10cm in diameter and sufficiently long to run from post to post to which they shall be tied with strong ropes. The method of projecting rails beyond the posts and tying together where they meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m high shall be formed when so required by the Engineer for further protection. Proper provision shall be made for lighting at night and watchmen shall be

kept to see that this is properly done and maintained. In addition to the normal lighting arrangements, the Contractor shall provide, whenever such work is in progress, battery operated blinking lights (6 volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The Contractor shall also provide and display special boards printed with fluorescent prints indicating the progress of work along the road. In the event of the Contractor not complying with the provisions of the clause, it may be carried out by the Engineer and the cost recovered from the Contractor besides claiming liquidity damages from the Contractor. In all such cases the work may be carried out by Board. The Contractor shall be held responsible for all claims for compensation as a result of accident or injury to persons / non-provision of red flags.

The Contractor shall at his own cost provide all notice boards before opening of roads as directed by the Engineer.

Arrangements shall be made by the Contractor to obtain permission from CMC and traffic authorities for working and to direct traffic when work is in progress. No separate payment shall be paid for this item of work.

5.19 REFILLING TRENCHES:

- a) With a view to restrict the length of open trenches, on completion of the pipe laying operations, refilling of trenches shall be started immediately by the Contractor. Pipe laying and testing shall follow closely upon the progress of trench excavation and the Contractor shall not be permitted more than 500 metres of trench excavation to remain open while awaiting testing of the pipe line.
- b) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.
- c) Walking or working on the completed pipelines shall not be permitted unless the trench has been filled to a height of at least 30cm over the top of the pipe except as may be necessary for tamping etc., during back filling work.
- d) Filling-in with excavated earth shall be done in layers not exceeding 150mm in thickness accompanied by adequate watering, ramming etc. so as to get good compaction upto 300mm above the top of the pipe. Above this level, excavated earth shall be placed in layers of 200mm watered and compacted by tamping.
- e) The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

- f) Before and during the backfilling of the trench, precautions shall be taken against the floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.

5.20 MEASUREMENT AND PAYMENT:

The payment of excavation shall be made on quantity basis as per the actual dimensions of the trench excavated limited to the width as per specification drawings.

- a) Trench Excavation:

The length of the trench excavation shall be measured along the center line of pipe at various depths stated in the Bill of Quantities, the total length being segregated into stretches according to the various depths of excavation contained in the Bill of Quantities to fall in to the specified categories. Within each stretch, the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the center before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurement shall be to the top level of the bottom of the pipeline. The width of the trench shall be measured on the basis of the specification drawing. No additional payment shall be made for the deepening and widening at sockets specials, hunching or surrounds beyond the dimensions mentioned in the specification drawing. For excess width excavated the road cutting charges to be paid by the Contractor.

The measurement of depth and width of trench shall be taken at every 20 metres along the alignment and at every change in direction and diameter of the pipe.

- b) Structure:

Measurement for structure excavation shall be made as per the projection in plan of the outermost edges of the structure as per the plan at the bottom.

- c) Rock excavation:

The depth of rock excavation measured for payment shall not exceed the corresponding depth in ordinary excavation plus 150mm both for structure and trench excavations.

The maximum trench widths measured for payment in rock excavations will be as per specification drawing.

In all above cases, no payment will be made for additional selected fill, lean concrete, bedding cradling or chunching concrete that may be specified or ordered by the Engineer as a consequence of excavating beyond the limits specified in the contract documents or ordered by the Engineer.

d) Disposal of excavated material:

All the excavated material shall be carted away and the contractor shall be paid in the following manner for disposal of the same. An item is provided in the bill of quantities and it includes loading, unloading, transporting to a site upto a distance of 10kms as directed by the Engineer.

e) For excess width of excavation than specified, no payment will be made and the Contractor has to bear the cost of restoration.

5.21 PERMANENT REINSTATEMENT:

a. Highways:

Restoration and re-instatement of Highways head and sidewalk surface shall be done by Highway Department and CMWSS Board will pay the cost.

b. Municipal Roads:

The reinstatement of the Municipal roads, i.e. Asphalt and WBM roads and side walk surface will be carried out by the Municipal Roads Department of the Chennai Municipal Corporation or by the Highways Department and CMWSSB Board will pay the cost.

c. Private properties:

However, any damages to the private properties such as compound wall, fencing, etc. during the execution or immediately afterwards due to contractor carelessness, the same has to be restored by the Contractor to the original shape at Contractor's own cost.

5.22 SHORING AND STRUTTING:

Open cuttings and trenches shall be suitably shored, sheeted and braced, if required by the Engineer or by site conditions or to meet local laws, for protecting life, property of the work.

Adequate shoring and strutting shall be provided by the Contractors at their own cost. Warped or deformed timber shall not be used. The shoring shall project at least 150mm above ground level and shall extend to a suitable depth below the bottom of the

trench. Wherever necessary, the planks or struts shall be driven by compressed air pile drivers. The planks shall be fixed close enough to avoid any running in of sand earth through the joints. The shoring material shall not be of sizes less than those specified below, unless steel sheet piling is used or unless approved by the Engineer in writing.

- a) Planks : 38mm thick
- b) Walling pieces : 100 cm x 100 cm
- c) Struts : 15 cm x 20 cm

For walling pieces round timber shall not be allowed. In a vertical plane, there shall be at least three struts or more as directed by the Engineer. They shall rest on walling pieces. The spacing of the struts shall be as per the requirement of the design. At the bottom, extra struts shall have to be provided if ordered by the Engineer. The rates for excavation do not include the cost of shoring, which shall be paid for separately as per relevant item of the Bill of Quantities. The Contractors shall be held responsible for providing secure shoring, and for adopting every other precaution, which may be necessary for protecting nearby structures, which are likely to be damaged as a result of excavation. The Contractors shall design the shoring required for actual site conditions and shall provide shoring accordingly. The design shall be submitted to the Engineer on demand. The shoring shall be so designed that lowering of pipe of normal length or any other pipe laying operation does not necessitate the removal of any strut or any other member of shoring. If the Engineer requires the adoption of any special measures or precautions, the Contractor will comply with the same immediately. If any part of a nearby structure is cut out or removed for facility of work, the same shall be made good on completion of the work by the Contractors at their cost.

In the event of the Contractors not complying with the provisions of this contract in respect of shoring the Engineering may, with or without notice to the Contractors, put up shoring or improve shoring already put up or adopt such other measures as he may deem necessary, the cost of which shall be recovered from the Contractors. Such action on the part of the Engineer, shall not, however absolve the Contractors of their responsibilities under this contract.

No part of the shoring shall, at any time, be removed by the Contractors without obtaining permission from the Engineer. While taking out shoring planks, the hollows formed shall be simultaneously filled in with soft earth and shall be well compacted as directed.

No payment will be made if the Contractors leave shoring material in the trench on his own or merely to suit their own convenience. The work of providing shoring shall be measured and paid for on the basis of areas of planks provided up to ground level and no separate payment will be made for providing and fixing of walling pieces, struts, dog spikes etc. the cost of which shall be deemed to have been covered by the rate for shoring.

The planks shall project at least 150mm above the ground level. For the purpose of payment, however, measurements shall be taken up to ground level only and no payment will be made for planking above ground level.

5.23 QUALITY CONTROL TEST:

Trenches other than in roads and paved areas shall be backfilled as specified in Clause 5.20.

CHAPTER 6 - BRICK WORK

6.1 BRICK WORK:

6.1.1 Masonry Mortars:

Proportioning:

Mix proportion of cement sand mortar shall be as indicated. The mixes specified are by volume. 50 kg. of cement shall be taken as equal to 0.035 cum. to determine bulk. The quantity of water to be added to cement sand mortar shall be such that working consistency is obtained. Excess water shall be avoided.

Preparation of Cement Mortar:

Mixing shall be done preferably in a mechanical mixer. If done by hand, mixing operation shall be carried out on a clean watertight platform. Cement and sand shall be mixed dry in the required proportion to obtain a uniform colour. The required quantity of water shall then be added and the mortar hoed back and forth for 5 to 10 minutes with additions of water to a workable consistency. In the case of mechanical mixing, the mortar shall be mixed for at least three minutes after addition of water. Cement mortar shall be freshly mixed for immediate use. Any mortar, which has commenced to set, shall be discarded and removed from the site.

Time of use of Mortar:

Mortars with cement as an ingredient shall be used as early as possible after mixing, preferably within half an hour from the time water is added to the mix or at the latest within one hour of its mixing.

Workability of Masonry Mortar:

The working consistency of the mortar is usually judged by the work during application. The water used shall be enough to maintain the fluidity of the mortar during application, but at the same time it shall not be excessive leading to segregation of aggregates from the cement.

6.1.2 Brick Masonry:

a. Manufacture:

Common burnt clay building bricks shall conform to the requirements of IS: 1077 and shall be of quality not less than class 20 with moisture absorption rate not exceeding

15 percent as defined in IS:1077. The bricks shall be chamber burnt and shall have sharp corners and smooth faces and shall not be damaged in any manner and sizes shall conform to the works sizes specified with tolerances as given in 6.2 IS: 1077.

b. Samples:

The Contractor shall deliver samples of each type of brick to the Engineer, and no orders shall be placed without the written approval of the Engineer. All the bricks used in the works shall be of the same standard as the approved samples. The samples shall be preserved on site, and subsequent deliveries shall be checked for uniformity of shape, colour and texture against the samples. If in the opinion of the Engineer any deliveries vary from the standard of the samples, such bricks shall be rejected and removed from the site. Samples of bricks shall be tested in accordance with IS: 3495 by the Contractor.

c. Uniformity:

The bricks selected for exposed pointed brickwork walls shall be of uniform colour, deep cherry red or copper colour, and uniform texture. Only such bricks as are permitted by the Engineer shall be used.

6.2 SETTING OUT:

All brickworks shall be set out and built to the respective dimensions, thickness and heights as indicated.

6.3 SCAFFOLDING:

Scaffolding shall be strong to withstand all dead, live and impact loads, which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work overhand work shall not be allowed.

For exposed brick facing double scaffolding having two sets of vertical supports shall be provided. For brickwork, which is to be plastered over, single scaffolding may be provided. In single scaffolding one end of the putlogs shall rest in the hole provided in the header course of brick masonry. Not more than one header for each putlog shall be left out. Such holes shall not be allowed in the case of pillars of narrow masonry portions between openings, which are less than one metre in width or are immediately under or near the structural member supported by the walls. The holes left shall be made good on removal of scaffolding to match with the face work / surrounding area.

Timber or bamboo scaffolds shall be erected in accordance with the provisions contained in IS: 3696 (Part I) - 1987. Safety code for scaffolds and ladders, Part I - Scaffolds, to ensure safety of workmen and others. Steel scaffolding shall be erected in accordance with the provisions contained in IS: 2750-1964. Specifications for steel scaffolding and relevant provisions of IS: 3696 (Part I) - 1987 or safety code for scaffolds (Parts I & II) and ladders shall be followed.

6.4 SOAKING OF BRICKS:

Bricks shall be soaked in water before use for a period of the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When bricks are soaked, they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on clean place, where they are not again spoiled by dirt, earth, etc.

6.5 LAYING:

All loose materials, dirt and set lumps of mortar which may be laying over the surface on which brickwork is to be freshly started, shall be removed with a wire brush and surface wetted slightly. Bricks shall be laid on a full bed of mortar. When laying, the bricks shall be properly bedded and slightly pressed with handle of trowel so that the mortar can get into all the pores of the brick surface to ensure proper adhesion. All the joints shall be properly flushed and packed with mortar so that no hollow spaces are left. Care shall be taken to see that the required quantity of water is added to the mortar at the mixing platform to obtain required consistency. Addition of water during laying of the course shall not be permitted. In the case of walls two bricks thick and over, the joints shall be grouted at every course in addition to bedding and flushing with mortar.

Bricks shall be laid with frog up. However if the top course is exposed, bricks shall be laid with frog down. Care shall be taken to fill the frogs with mortar before embedding the bricks in position.

All quoins shall be accurately constructed and the height of courses checked with storey rods as the work proceeds. Acute and obtuse quoins shall be bonded, where practicable, in the same way square quoins; obtuse quoins shall be formed with squint showing a three quarter brick on one face and quarter brick on the other.

6.6 BOND:

All brickwork shall be built in English Bond, unless otherwise indicated. Half brick walls shall be built in stretcher bond. Header bond shall be used for walls curved on plan for better alignment. Header bond shall also be used in foundation footings, stretchers may be used when the thickness of wall renders use of headers impracticable. Where the thickness of footings is uniform for a number of course of the footings shall be headers.

Half or cut bricks shall not be used except where necessary to complete the bond.

Overlap in stretcher bond is usually half brick and is obtained by commencing each alternate course with a half brick. The overlap in header bond which is usually half the width of the brick is obtained by introducing a three quarter brick in each alternate course at quoins. In general, the cross joints in any course of brickwork shall not be nearer than a quarter of brick length from those in the course below or above it.

6.7 UNIFORMITY:

The brickwork shall be built in uniform layers; corners and other advanced work shall be raked back. No part of a wall during its construction shall be raised more than one metre above the general construction level, to avoid unequal settlement. Parts of walls left at different levels shall be properly raked back. Tothing may be done where future extension is contemplated but shall not be used as an alternative to taking back.

For half brick partition to be keyed into main walls, indents shall be left in the main walls.

6.8 THICKNESS OF JOINTS:

The thickness of joints shall be 10mm + 3 or – 3mm, unless otherwise specified. Thickness of joints shall be kept uniform. Slight difference to thickness of bricks shall be adjusted within joint thickness. Where brickwork is to match the existing work, the joints shall be of the same thickness as in the existing work.

6.9 STRIKING JOINTS:

Where no pointing, plastering or other finish is indicated, the green mortar shall be neatly struck flush. Where pointing, plastering or other finish is indicated, the joints shall

be squarely raked out to a depth not less than 10mm for plastering and 15mm for pointing.

6.10 CURING:

The brickwork shall be constantly kept wet for at least 7 days.

6.11 FINISHING:

In case of walls one brick thick and under, at least one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

For exposed brickwork selected bricks of the specified class and sub-class shall be used for the face work, where however, use of facing bricks is indicated, brick walls shall be faced with facing bricks. No rubbing down of brickwork shall be allowed.

Brick walls shall be plastered, pointed or otherwise finished, as indicated. Joints of external faces of brick walls in foundation upto 15cm below ground level and of internal faces of brick walls in foundation and plinth below sub-floor level shall be struck flush when the mortar is green, as the work proceeds.

6.12 CLEANING:

Face of brickwork shall be cleaned on the same day it is laid and all mortar droppings removed.

6.13 CONSTRUCTION DETAILS:

Holes for Pipes etc.

All necessary holes for pipes, air flues, ventilators, etc. shall be cut or formed as work proceeds and grouted in cement and sand mortar 1:3 of cement concrete 1:2:4 as required and made good.

CHAPTER 7 - CONCRETE WORKS

7.1 CONCRETE:

General:

- a. The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix whether reinforced or otherwise, shall conform to the applicable portions of this Specification.
- b. The Engineer shall have the right to inspect the source/s of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work.

7.2 MATERIALS FOR STANDARD CONCRETE:

The ingredients to be used in the manufacture of concrete shall consist solely of Portland cement, clean sand, natural coarse aggregate, clean water, and admixtures, if Specifically called for and conditions at site warrant its use.

- a. **Cement:** Cement shall conform to IS: 12269 – 1987.
- b. **Aggregates:** Aggregates shall comply with the requirements of IS: 383 – 1970.
 - i. **General**
 - a) "Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete.
 - b) "Coarse Aggregate" is aggregate most of which is not passed through on 4.75mm IS sieve.
 - c) "Fine aggregate" is aggregate most of which is passed through on 4.75mm IS sieve.
 - d) All fine and coarse aggregate proposed for use in the works shall be subject to the Engineer's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer.
 - e) Aggregates shall, except as noted above, consist of natural sands, crushed stone from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering of limited porosity and free from deleterious materials that may cause

corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the “mix design” and preliminary tests on concrete specified later.

- f) Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without the special permission of the Engineer.

ii. Fine Aggregate:

a) General:

Fine aggregate shall consist of natural or crushed sand conforming to IS: 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt or other deleterious substances, which can be injurious to the setting qualities / strength / durability of concrete.

- (i) **Machine-made Sand:** Machine-made sand will be acceptable, provided the constituent rock-gravel composition shall be sound, hard, dense, non-organic, uncoated and durable against weathering.
- (ii) **Screening and Washing:** Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.
- (iii) **Foreign material limitations:** The percentage of deleterious substances in sand delivered to the mixer shall not exceed the following:

Percent by weight:

		Uncrushed	Crushed
(A)	Material finer than 75 micron I.S. Sieve	3.00	15.00
(B)	Shale	1.00	--
(C)	Coal and lignite	1.00	1.00
(D)	Clay lumps	--	--
(E)	Total of all above substances including items (A) to (D) for uncrushed sand and items (C) and (D) for crushed sand	5.00	1.00

b) Gradation:

- (I) Unless otherwise directed or approved by the Engineer, the grading of sand shall be within the limits indicated under here:

IS Sieve	Percentage passing for			
	Grading Zone – I	Grading Zone – II	Grading Zone – III	Grading Zone AVE
10mm	0	100	100	100
4.75mm	90 – 100	90 – 100	90 – 100	95 – 100
2.36mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18mm	30 – 70	55 – 90	75 – 100	90 – 100
600micron	15 – 34	35 – 59	60 – 79	80 – 100
300micron	5 – 20	8 – 30	12 – 40	15 – 50
150micron	0 – 10	0 – 10	0 – 10	0 – 15

- (II) Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron I.S. sieve, by total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. sieve or to percentage passing any other sieve size on the coarser limit of Grading Zone I or the finer limit of Grading Zone AVE. Fine aggregates conforming to Grading Zone AVE shall be used. Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

c) Fineness Modulus:

The sand shall have a fineness modulus of not less than 2.2 or more than 4.2. The fineness modulus is determined by adding the cumulative percentages retained on the following I.S. sieve sizes (4.75mm, 2.36mm, 1.18mm, 600micron, 300micron and 150 micron) and dividing the sum by 100.

iii. Coarse Aggregate:

- a) Coarse aggregate for concrete, except as noted above, shall conform to IS: 383. This shall consist of crushed stone and shall be hard, strong, durable clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

b) Screening and Washing:

Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer.

c) Grading:

Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits.

IS Sieve Designation	Percentage passing for single sized aggregate of normal size					Percentage passing for graded aggregate of normal size			
	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
63 mm	100	--	--	--	--	100	--	-	--
40 mm	85 100	100	--	--	--	95 100	--	-	--
20 mm	0 20	85 100	100	-	--	30 70	95 100	100	--
16 mm	--	--	85 100	100	--	--	--	90 100	--
12.5 mm	--	--	--	85 100	100	--	--	--	90 100
10 mm	0 5	0 20	0 30	0 45	85 100	10 35	25 35	30 70	40 85

- d. **Water:** Water for mixing concrete, mortar or grout shall conform to IS:456 – 2000. If required to do so by the Engineer, the Contractor shall take samples of the water and test them for quality.

7.3 TRANSPORTING AND DEPOSITING CONCRETE:

Mixing plant shall be located as close as possible to the point of placement. Concrete shall be placed within 30 minutes after mixing and shall be transported from the mixer to its final placement as rapidly as practicable, taking care to see that no segregation or loss of ingredients take place. It shall also be ensured that the concrete is of the required workability at the point and time of placing.

Dropping of concrete from an excessive height or running or working it a long forms will not be permitted. Any concrete which, before placement has begun to set and has become stiff shall be rejected.

Concrete shall not be disturbed after it has been placed in the form and has begun to set. Concrete shall be carefully placed in horizontal layers which shall be kept at an even height throughout the work. Concrete shall not be allowed to slide or flow down sloping surfaces directly into its final position but shall be placed in its final position from the skips, trucks, barrows, down pipes or other placing machines or device or, if this is impossible it shall be shoveled into position, care being taken to avoid separation of the

constituent materials. Concrete placed in horizontal slabs from barrows or other tipping vehicles shall be tipped into the face of the previously placed concrete.

Concrete dropped into place in the work shall be dropped vertically. It shall not strike the formwork between the point of its discharge and its final place in the work and except by approval of the Engineer, it shall not be dropped freely through a height greater than 1.5 metres. Chutes & Conveyor belts shall be so designed that there is no segregation or loss of mortar and shall be provided with a vertical tapered down pipe or other device to ensure that concrete is discharged vertically into place.

Where a lift of concrete is built up in layers each layer shall be properly merged into the proceeding layer before initial set takes place.

7.4 QUALITY ASSURANCE

General Procedure:

A. General:

In order to achieve the required strength and associated properties of concrete, proper control of the Water / Cement ratio by weight need be enforced. The strength shall be prime consideration and W.C. ratio as prescribed by Engineer in charge shall have to be observed. Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for mild/moderate exposure condition (as applicable) with Normal Weight Aggregates of 20 mm Nominal Maximum Size shall be complied with as given in the Table 5 of IS 456-2000.

B. Operators:

At no time whatsoever will the mixer operator or those supervising or inspecting the works be permitted to alter the quantity of water specified by the Engineer for mixing the concrete. Batching shall be accurate and as specified by the Engineer.

C. Water / Cement Ratio:

The Water / Cement ratio will be determined after mix trials by the Contractor in the presence of the Engineer or his representative. If batching is by volume, the Contractor shall be required to fabricate such volumetric batches and water containers as the Engineer may determine and require so as to simulate the ideals of the trial mix without recourse to assessments by site staff and workmen.

D. Weighing:

The Contractor shall make available always a weighing machine if so required, guaranteed by the Contractor for its accuracy, for weighing cement and batches of aggregate as and when the Engineer or his representative or his assistant may require. The machine shall be capable of weighing upto 75 Kilograms and shall be accurate to half (0.5) Kilogram.

E. Compaction:

All concrete shall be thoroughly compacted and fully worked round the reinforcement by vibration just sufficiently so that the appearance of laitance is kept to a minimum and in such manner as directed by the Engineer's Representative. Under no circumstances shall concrete be compacted by trowels or the like.

F. Transport and Placing:

Fresh concrete from the mixer shall be transported where required by the quickest and most efficient means so as to prevent pre-set or segregation or any loss of ingredients and shall maintain required workability. Any laitance from previous mixes shall be removed.

7.5 SAMPLING, TESTING AND STORAGE OF MATERIALS:

Samples of aggregates for mix design and determination of suitability shall be taken under the supervision of Engineer and delivered to the laboratory well in advance of the scheduled placing of concrete. Records of tests made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Engineer in advance of the work for use in determining aggregate suitability. The cost of all such tests, sampling etc. shall be borne by the Contractor.

Materials shall be tested as hereinafter specified and unless specified otherwise, all sampling and testing shall be performed by Testing Laboratory approved by Board at the Contractor's expense.

A. Cement:

Cement shall, whether supplied by the Board or not, comply with the requirements of IS: 12269. The testing laboratory at the discretion by the Engineer, shall perform such tests as are deemed necessary. Cement bags or bulk silos shall be tagged

for identification at location of sampling. Tests will include tensile tests and weighing the cement supply to check for net weight received at site and used in the works.

1. On arrival at site, cement shall be stored in weatherproof silos designed for the purpose or in dry weather-tight and properly ventilated structures with floors raised 15 to 20cm above ground level, 30cm away from walls and with adequate provision to prevent absorption of moisture or flooding. All storage facilities shall be subject to approval by the Engineer and shall be such as to permit easy access for inspection and identification. Each consignment of cement shall be kept separately and the Contractor shall use the consignments in the order in which they are received. Any cement in drums or bags, which have been opened, shall be used immediately. Different types of cement shall be kept in clearly marked separate storage facilities. Not more than 15 bags shall be stacked vertically in one pile. Cement shall be stored in double locking arrangement, so that cement transactions can be with the knowledge of supervisory staff. Daily account of cement shall be maintained by the Contractor in the prescribed register and shall be made available to inspecting authorities for store verification.
2. The Contractor shall provide from each consignment of cement delivered to the site such samples as the Engineer may require for testing. Any cement which is, in the opinion of the Engineer, lumpy or partially set shall be rejected and the Contractor shall promptly remove such cement from the site.
3. Cement which has been stored on the site for more than ninety (90) days and cement which in the opinion of the Engineer is of doubtful quality shall not be used in the works until it has been retested and test sheets showing that it complies in all respects with the relevant standard have been delivered to the Engineer.

B. Water for Concrete Mixing & Curing:

Water shall be clean, clear and free from injurious quantities of salt, traces of oil, acids, alkalies, organic matter and other deleterious materials. The sources of water shall be approved by the Engineer and the containers for conveyance; storage and handling shall be clean. If necessary, standard cement tests shall be conducted using the water

intended to be used, in comparison with those adding distilled water to check quality of water.

Water shall meet the requirement of 4.3 of IS: 456 – 2000. Generally potable water is fit for mixing and curing.

C. Aggregates:

Aggregate will be tested before and after concrete mix is established and whenever character or source of material is changed. Tests will include a sieve analysis to determine conformity with limits of gradation.

1. Samples of aggregates 50 kg. in weight will be taken by the Contractor at source of supply and submitted to the Engineer before placing orders. These samples if approved shall remain preserved in the Engineer's care for reference and the type of aggregate used in the works may not be altered without Engineer's prior approval.

2. Aggregate shall be obtained from an approved source and shall conform to the requirements of IS: 383.

For the aggregate grading, in table of IS: 383 – 1970 shall be applicable. Aggregate shall not be flaky or elongated particles, defined as particles having a maximum dimension greater than five times the minimum dimension. Aggregate shall have water absorption not exceeding two percent when tested in accordance with IS 383.

3. The Contractor shall sample and carry out analysis in the presence of the Engineer's representative, or the fine aggregate and each nominal size of coarse aggregate in use employing the methods described in IS: 383 and 2386 at least once in each week when concreting is in progress and such more frequent intervals as the Engineer may require. The grading of all aggregates shall be within the respective limits specified in the codes. For aggregates, which vary more than the approved fineness modulus, the Engineer may instruct the Contractor to alter the relative proportions of the aggregate in the mix to allow for such difference, or may require further trial mixes.

4. Storage of aggregates shall be provided at each point where concrete is made such that each nominal size of coarse aggregate and the fine aggregate shall be kept separated at all times. Contamination of the aggregates by the ground or other foreign matter shall be effectively prevented at all times, and each heap of aggregate shall be capable of draining freely. The Contractor shall ensure that graded coarse aggregates are dumped, stored and removed from store in manner that does not cause segregation.

Coarse aggregate shall be piled in layers not exceeding 1.2m in height to prevent coning or segregation. The aggregates must be of specified quality not only at the time of receiving at site but more so as the time of loading into mixer.

Wet fine aggregate shall not be used until, in the opinion of the Engineer, it has drained to constant and uniform moisture content, unless the Contractor with the knowledge of the Engineer measures the moisture content of fine aggregate and adds water in each batch of concrete mixed to allow for the water contained in the fine aggregate.

7.6 MIX DESIGN:

Mix design is normally a prerequisite to any concreting job and will be required on all major works. If so required, an approved testing laboratory shall, at the Contractor's expense, design a mix for each class of concrete and shall submit full details of the mix designs to the Engineer for his approval. The Engineer's representative and the Contractor shall clearly code each approved mix with a number and date, and file all details for identifying and reproducing exactly the same mix.

A. General:

Each mix design shall be such that the aggregate shall comprise fine aggregate and coarse aggregate of the size specified and the combined aggregate grading shall be continuous. Aggregate shall be calculated by weight, and batching procedures shall be established. The cement content by weight shall not be outside the minimum and maximum limits calculated from the minimum and maximum dry aggregate to cement ratios specified. The mixes shall be designed to produce average concrete cube strength at twenty eighth day after manufacture not less than the trial mix test strength specified. The water / Cement ratio shall be as per Table 5 of IS 456-2000 for mild/moderate exposure conditions(as applicable).

B. Preliminary Mix:

The proportions of cement, aggregate and water determined by the Contractor in his mix design shall be used in preliminary mix of concrete made and tested for strength and workability under laboratory conditions observing the appropriate requirements. These preliminary mixes shall be repeated with adjusted proportions as necessary until concrete mixes meeting the requirements of the preliminary and trial mix tests specified and with the workability defined here in have been produced. If at any time during construction of the works, the source of cement or aggregates is changed, or the grading of the aggregate alters, then further preliminary mixes shall be undertaken.

C. Trials:

After the Engineer's approval of the preliminary concrete mix design for each class of concrete and during or following the carrying out of the preliminary tests, the Contractor shall prepare a trial mix of each class in the presence of the Engineer. The trial mixes shall be mixed for the same time and handled by means of the same plant that the Contractor propose to use in the works. The proportion of cement, aggregates and water shall be carefully determined by weight in accordance with the approved mix design (or modified mix design after preliminary tests) and sieve analyses shall be made, by approved methods of the fine aggregate and each nominal size of coarse aggregate used.

D. Admixtures:

Admixtures shall mean material added to the concrete materials during mixing for the purpose of altering the properties of normal concrete mixes. If the Contractor wishes to use admixtures, otherwise than as expressly ordered by the Engineer, he shall first obtain the Engineer's written permission. The methods of use and the quantities of admixture used shall be subject to the Engineer's approval, which approval or otherwise shall in no way limit the Contractor's obligations under the contract to produce concrete with the specified strength and workability. Concrete of any class containing an admixture shall be separately designed and have separate preliminary tests and trial mixes made and tested for approval by the Engineer as if it were a separate class of concrete.

Waiver of Mix Design and Weigh Batching:

On certain works, the Engineer may waive the requirement of designing mixes and may allow the use of established nominal mix proportion, provided always that preliminary trials are made to establish the volumetric batching procedure and mix strengths. The Contractor will ensure that any established procedure approved by the Engineer is strictly adhered to, so as to achieve consistent strength, durability and economy of the concrete while ensuring approved workability of the mix. Any waiver of mix design or weigh batching will not relieve the Contractor of his obligations to consistently produce concrete of the specified and approved strength and durability as determined by works tests. However in any particular work / part of work, the Engineer may decide to adopt mix design (mix) concrete.

Workability:

The workability of each class of concrete shall be such that satisfactory compaction can be obtained when the concrete is placed and vibrated in the works. There shall be no tendency to segregate when it is handled, transported and compacted by the methods, which the Contractor proposes to use when handling, transporting and compacting that class of concrete in the works.

Grades of concrete:

The concrete shall be in grades designed in Table 2 IS: 456 – 2000.

Concrete Mix Design:

Procedure for designing concrete mixes shall be as per IS: 10262 – 82. “Recommended guidelines for concrete mix design”.

7.7 BATCHING:**Cement:**

All cement used in making concrete shall be measured by weight either with an approved weighing machine or by making the size of each batch of concrete such as to require an integral number of complete bags of cement of weight consistent with the requirements of IS : 12269 - 1987. In case of ordinary mixes (if allowed by the Site Engineer), the cement bag shall be taken to be 50 kg. (35 litres).

Aggregate:

The fine and coarse aggregate shall be measured separately either by volume in gauge boxes or by weight using machines with weigh batching attachments. For high grade concrete, the fine aggregate shall be measured singly or cumulatively by weight. The Engineer will rule on this requirement.

Gauge Boxes:

Gauge boxes shall be soundly constructed by the Contractor, with the approval of the Engineer and shall be of timber or of steel to contain exactly the volume of the various aggregates required for one batch of each mix. Each gauge shall be clearly

marked with the mix code and the aggregate for which it is intended. When calculating the size of the gauge box for fine aggregate, allowance shall be made for the bulking of the fine aggregate due to the average amount of moisture contained in the stockpiles on the site. Before the Contractor shall put any gauge box into use on the site, he shall obtain the approval of the Engineer of the size and construction of such gauge box.

Water Container:

Containers for measuring water shall be soundly constructed of metal to contain the exact quantity of water required for a batch of mix, due allowance having been made for the moisture content of the aggregates, or such fractions of the quantity as are approved by the Engineer. Containers shall have spoons, the pill levels of which determine the quantity. Fixed containers shall be elevated and have overflow pipes, which determine the quantity held in the container, and shall have an outlet valve and hose fixed to the bottom of the container. Before any container is put into use, the approval of the Engineer shall be obtained.

Weigh-Batching:

Weigh batching machines shall provide facilities for the accurate control and measurement of the materials either singly or cumulatively and shall be capable of immediate adjustment by operators in order to permit variations if ordered by the Engineer. All weight dials shall be easily visible from the place at which filling and emptying of the hoppers are controlled.

Addition of Water and Mixing:

A. Water:

The addition of water to a mixer shall be controlled such that between five and ten percent of the water enters the mixer before the cement and aggregate and a further five to ten percent of water enters the mixer after the said materials have been batched. The remainder of the water shall be added at a uniform rate with the said materials. The water-measuring device shall also be readily adjustable so that the quantity of water added to the mixer can, if necessary in the opinion of the witnessing Engineer's representative be varied. The natural moisture contents of the aggregates shall be determined before the commencement of concreting or at such intervals as may be necessary or as required by the Engineer. The Contractor shall make due allowance for

the water contained in the aggregate when determining in consultation with the Engineer's representative, the quantity of water to be added to each mix, and shall adjust the amount of water added to each mix to maintain consistently the approved water / cement ratio of the mixed concrete. All important concrete shall be machine mixed to give complete coating of cement mortar on each coarse aggregate particle and to produce uniform coloured concrete with uniform distribution of materials. The mixer shall be run minimum 1 ½ minutes. In case, for a minor job, hand mixing is permitted by the Engineer, it shall be done on smooth watertight platform not allowing the added water to flow out. The fine aggregate shall be spread in uniform thickness layer over which cement as required shall be placed and they shall be mixed thoroughly to give dry mortar. Water is then added gradually in required proportion, turning the mass, to give desired consistency mortar. The required quantity of coarse aggregate is then placed on mixing platform, wetted and mortar added. The entire mass is turned and returned to give uniform concrete of required consistency. 5% additional cement shall be used for hand mixed concrete.

B. Admixtures:

Any admixtures approved by the Engineer, which may be used, shall be measured separately in calibrated dispensers and shall be added to the mixture together with the water.

C. Uniformity of Mix:

Concrete shall be mixed in batches in plant capable of mixing the aggregates, cement and water (including admixtures, if any) into a mixture uniform in colour and consistency and of discharging the mixture without segregation.

D. Contractor's Returns:

The Contractor shall render to the Engineer, daily return for each class of concrete of the number of batches mixed, and total volume of concrete placed, the number of batches wasted or rejected and the weight of cement used. In case of ordinary mixes, where permitted, the cement bags consumed for quantities of various classes of concrete shall be furnished. In addition daily details of time of starting concrete, closure, No. of batches through mixer, W.C. ratio, slump, date of striking form works etc. shall be

maintained. This day-to-day record shall be authenticated by responsible supervisory staff.

E. Plant and Equipment Generally:

All mixing and batching plants, boxes, containers and other equipment shall be maintained free of defects or of set concrete or cement and shall be cleaned before commencing mixing. At such intervals as may be directed by the Engineer, the Contractor shall provide weights, containers and equipment necessary for testing the accuracy of the weighting plant, water measuring plant and admixture dispenser.

7.8 CONCRETING:

Preparation:

The Contractor shall clear from the surface of the foundations or previously placed concrete all oil, loose fragments of rock, earth, mud, timber and any other foreign matter and shall clear standing water and wash the surface of a previous lift of concrete to the satisfaction of the Engineer.

a. Laitance:

Where laitance on a lift of concrete is evident or if a substantial bond between this lift or bay of concrete and the next is required, in the opinion of the Engineer's representative, the Contractor shall have the surface wire brushed after initial set of the concrete or have it bush-hammered at no extra cost to the Board. Any reinforcing bars covered in laitance shall be wire brushed to clean the surface of the metal.

b. Blinding:

As ordered by the Engineer, or as shown on the drawings the formation surfaces on which concrete is to be placed shall be covered with either blinding concrete not less than 75mm thick, or waterproof, building paper, or polythene sheeting immediately after completion of the final trimming of the excavation.

7.9 INSPECTION:

Concrete shall not be placed until the Engineer has inspected the formwork and the reinforcing steel, and taken necessary measurements of the latter, and has approved the surface upon which the concrete is to be placed.

a. Transporting:

Fresh concrete shall be transported from the mixer to its place in the works as quickly and as efficiently as possible by methods, which will prevent pre-set or segregation. If segregation has nevertheless occurred in any instance, the materials shall be remixed or discarded at the opinion of the Engineer.

b. Placing:

Fresh concrete shall be placed and compacted before initial set has occurred and in any event, not later than thirty minutes from the time of mixing. Concrete shall be carefully placed in horizontal layers which shall not be allowed to slide or flow down sloping surfaces but shall be placed in its final position from skips, or similar devices. If this is impracticable, it shall be shoveled into position care being taken to avoid segregation. No concrete shall be dropped more than 1.5m. If greater drops are necessary approved chutes may be used. If the concrete abuts against earth or any other material liable to become loose or to slip, care shall be taken to avoid falls of materials on the surface of the wet concrete.

As far as possible concrete for any particular portion shall be done in one continuous operation leaving construction joints, if specified by drawing.

Before commencing subsequent concrete on the one left incomplete, all the loose particles, laitance etc. shall be removed and surface shall be covered with thick cement slurry. The concrete compacted manually shall be laid in layers not more than 15 to 20cm. The successive layer shall follow within 30 minutes or earlier.

7.10 C COMPACTION:

All concrete placed in-situ shall be compacted with power driven or pneumatic internal type vibrators unless otherwise approved by the Engineer in writing, and shall be supplemented by hand spading and tamping where required. Vibrating by screed type vibrators may be used for thin slabs. There shall be sufficient and spare vibrators of adequate capacity to compact the work in hand.

a. Vibrators:

Vibrators shall be inserted into the uncompacted concrete vertically and at regular intervals. Where the uncompacted concrete is in a layer above freshly compacted

concrete, the vibrator shall be allowed to penetrate vertically for about 75 mm into the previous freshly compacted layer. The vibrators shall not be allowed to come into contact with the reinforcement of formwork nor shall they be withdrawn quickly from the mass of concrete but shall be drawn back slowly while in motion so as to leave no voids. Internal type vibrators shall not be placed in the concrete in any arbitrary manner nor shall concrete be moved from one part of the work to another by means of the vibrators. The vibrators shall have minimum 3600 (preferably 5000) impulses per minute.

b. Duration:

The duration of vibration shall be limited to that required to produce satisfactory compaction of the concrete without causing segregation. Vibration shall not be continued after the appearance of water or grout on the surface.

c. Hand compaction:

This shall be permitted exceptionally for small jobs by the Engineer. In such cases, compaction shall be attained by means of rodding, tamping, ramming and slicing with suitable tools. The thickness of concrete layers will also be suitably reduced when hand compaction is resorted to.

7.11 UNDER WATER CONCRETING:

No concrete shall be placed in water without the Engineer's written permission, which may only be granted if in his opinion it is not practicable to place the concrete in the dry. Concrete shall not be placed in running water nor shall concrete be allowed to fall through water. Any water entering the area where concrete is being placed shall, at the Contractor's expense, be kept clear of the concreting works. If under water concreting is permitted, the specified mix of concrete shall be strengthened by increasing the cement content by at least 10.0% and reducing the water / cement ratio to not more than 0.45, and the placing shall be only through a tremmie approved by the Engineer. The volume or mass of the coarse aggregate shall not be less than 1 ½ times not more than twice that of the fine aggregate. The material shall be so proportioned as to produce a concrete having a slump of not less than 100mm and not more than 180mm.

7.12 CURING:

All concrete shall be protected from the effects of sunshine, rain, running water or mechanical damage and cured by covering with jute, Hessian or similar absorbent material kept constantly wet or a layer of s and kept covered with water is also permissible for a continuous period of fourteen days at least from the date of placement. Should the Contractor fail to water concrete continuously, the Engineer may provide labour and materials required for curing and recover the cost from the Contractor.

7.13 FINISHING:

Immediately after removal of forms, any undulations, depressions, cavities, honeycombing, broken edges or corners, high spots and defects shall be made good and finished with C.M. 1:2, but the necessity of such finishing must be exceptional and total surface requiring finishing shall not exceed 1%. Where concrete surface is to receive plaster, the surface shall be roughened immediately after removal of forms and within a day thereof to secure a hold for the plaster. The rate of concrete is inclusive of this roughening and finishing. Concrete after finishing shall be cured for the full period.

7.14 JOINTS:

Construction Joints:

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

a. Submittal:

No concreting shall be started until the Engineer has approved the methods of placing, the positions and form of the construction joints and the size of lifts.

b. Jointing:

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 surface with water under pressure and brushing whilst the concrete is still green. Where the laitance cannot be removed whilst the concrete is 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, and washing down, and the surface to which fresh concrete is applied shall be clean and damp.

Expansion Joints:

Expansion joints are defined as 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.

a. The joint location and type will be as indicated in the drawings.

1. The Contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Engineer, demonstrate that the jointing materials can be applied satisfactorily and will last the life of the structure.
2. Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.

b. Jointing:

The surface of set concrete shall not be disturbed and concrete shall be placed against the dry finished surface.

3. If ingress of water or corrosive agents in the joint is possible, the steel, where such steel is continued, shall be cleaned and coated with two coats of an approved bituminous paint to a distance not exceeding 10mm.
4. Where specified, the surface of the set concrete shall be painted with two coats of an approved bituminous paint, which shall be allowed to dry before placing new concrete against it. Care shall be taken to prevent paint getting on the water stop, if any.
5. Expansion joints shall be formed by a separating strip of pre-formed compressible imperishable joint filler, to be approved by the Engineer.

7.15 TESTING OF CONCRETE:

Sampling and strength test of concrete shall be as per 14 of IS: 456 – 2000.

CHAPTER 8 - FORM WORK

8.1 MATERIAL:

All formwork for concrete work shall be mostly of M.S. Plates. The plates shall be free from wrinkles, lumps or other imperfections. 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 18 gauge for M.S. Plates.

The formwork may also be constructed of timber, or other approved material. It shall be firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. One copy of the Contractors shoring and formwork drawings shall be submitted to the Board for record purpose only and not for review or approval. Forms, shoring and false work shall be adequate for imposed live and dead loads including equipment and men, height of concrete drop, concrete and foundation pressures and stresses, wind pressures, lateral stability, and other safety factors during construction. The Contractor shall be responsible for the calculations and designs for the formwork. The Contractor shall be held solely responsible for any failure and for the safety of work and workmen. He shall pay necessary compensation, if need be, for damages to work, property and injuries to persons. The scaffolding, hoisting arrangements and ladders shall have easy approach to work spot and afford easy inspection.

All formwork shall be fabricated in compliance with the best modern practice, so that the finished surface is even, unblemished free of fins and true to line, level and shape as shown in the drawings. The forms shall comply with the requirements of IS: 456.

8.2 ARRANGEMENTS:

All formwork shall conform to the shape, lines, dimensions as shown on the plans of the concrete members. The formwork shall include all wedging, bracing, the rod, clamps, stop off boards and other devices necessary to mould the concrete to the desired shape. The formwork shall be constructed as to remain sufficiently rigid during the placing and compacting of the concrete and shall withstand the necessary pressure,

ramming and vibrations without any deflection from the prescribed lines and curves. It shall be properly strutted and braced in at least two directions. It shall be sufficiently tight to prevent loss of liquid slurry from the concrete. It shall be strongly and firmly erected. The moulds shall be free from holes, open joints, and other imperfections. The formwork shall be so arranged as to permit easy erection initially and easy removal without jarring or disturbing the concrete finally. Wedges and clamps shall be used wherever practicable instead of nails.

Where the depth of formwork exceeds 1.5 metres, the Contractors shall keep one side partly open, from which the concrete could be placed and the planking on the open side could be raised as the work proceeds. This will avoid segregation of material in concrete and also facilitate its proper vibration.

Before concrete is placed, all rubbish shall be removed from the interior of the form and the surfaces of the formwork in contact with concrete shall be cleaned and thoroughly wetted. The inside surface of the formwork shall be treated with a coat of lime, oil or any other material approved by the Engineer. Care shall be taken to see that the above approved composition is kept out of contact with the reinforcement. The slab centering shall be covered with "Double Wax" waterproofing paper or tar paper or polythene sheet as directed by the Engineer.

Where no special finish is desired and where form finish is acceptable, the formwork may be prepared out of water proof black board, which shall give a good finish to the concrete surface and thus there will be no necessity of providing cement plaster finish. For work, which are of repetitive nature, such as column footings, pedestals for pipes, pedestal footings; the formwork shall be fabricated out of steel plates and structurals to obtain uniform finish throughout the work. In all cases the formwork shall be inspected and approved by the Engineer, before any concreting is started. The Contractor shall, however, be solely responsible for the proper design, adequacy and stability of the formwork. If at any time, in the opinion of the Engineer, the formwork provided is not considered sufficiently rigid and / or is defective, the Contractor shall improve or strengthen the same in such manner as the Engineer may direct. In no circumstances shall form be struck off until the concrete attains adequate strength as required or without obtaining permission of the Engineer. All formwork shall be removed without such shock or vibration as would damage the concrete. Before the soffit and the struts are removed, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has hardened sufficiently. The responsibility for

the removal of the formwork whether whole or part, shall rest, entirely with the Contractor who must nevertheless be guided by the opinion of the Engineer in this regard. The work of striking and the removal of formwork shall be conducted in the presence of the Engineer and under personal supervision of a competent foreman in the employment of the Contractor.

8.3 REMOVAL OF FORMS AND SHORING:

Formwork shall be so designed as to permit easy removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the formwork shall be as approved by the Engineer after consideration of the loads likely to be imposed on the concrete and shall be in any case be not less than the periods shown below, depending on the ambient temperature.

1. Vertical surfaces of wall		1 day	
2. Columns & vertical sides of beams		2 days	
3. Slab bottoms with props left under		7 days	
4. Beam bottom with prop left under		7 days	
5. Removal of props under slabs			
Span	upto 4.5 m	7	days
Span	over 4.5 m	14	days
6. Removal of props to beam and arches			
Span	upto 6.0 m	14	days
Span	over 6.0 m	21	days

Sequence of striking formwork shall be approved by the Engineer.

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading. The Contractor shall be wholly responsible for repairing or reconstruction as directed by the Engineer the section of the works so affected.

1. Shoring and False work Removal:

In retaining wall construction shoring and false work shall not be removed until 21 days after concrete placement or until concrete has attained at least 90 percent of the

28 days design compressive strength as demonstrated by control test cylinders, whichever is earlier.

2. Restriction:

Construction equipment, or permanent loads shall not be imposed on columns, supported slabs, or supported beams until concrete has attained the 28 days design compressive strength as demonstrated by control test cylinders.

3. Concrete Curing during removals:

Concrete shall be thoroughly wetted as soon as forms are first loosened and shall be kept wet during the removal operations and until curing media or sacking is applied. Portable water supply with hoses or buckets shall be ready at each removal location before removal operations are commenced.

8.4 SURFACE TREATMENT & FINISH:

When the formwork is struck, all the faces of concrete shall be smooth and sound, free from voids and air holes. Any roughness or irregularity on the exposed surfaces shall be immediately filled up while the concrete is still green with cement grout, cement wash and / or 1 :1 mortar properly trowelled and finished. Such patching of the concrete face shall be carried only with the permission of the Engineer. If the concrete is found honey-combed, the honeycombed portion and whatever surrounding concrete that may be considered unsatisfactory by the Engineer shall be dismantled and fresh concrete of proper quality shall be provided at Contractor's cost.

CHAPTER 9 - REINFORCEMENT

9.1 GENERAL:

Reinforcement shall be either plain round mild steel bars Grade I as per IS: 432 (Part - I) or medium tensile steel bars as per IS: 432 (Part – I) or high strength deformed bars as per IS: 1786. Wire mesh or fabric shall be in accordance with IS: 1566. Substitution of reinforcement will not be permitted except upon written approval from the Engineer.

9.2 STORAGE:

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and / or be kept under cover or stored as directed by the Engineer. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

9.3 QUALITY:

- a. All steel shall be of Grade I quality unless specifically permitted by the Engineer. No re-rolled material will be accepted. If requested by the Engineer, the Contractor shall submit the manufacturer's test certificate for the steel. Random tests on steel supplied by the Contractor may be performed by the Engineer as per relevant Indian Standards. All costs incidental to such tests shall be at the Contractor's expense. Steel not conforming to specifications shall be rejected.
- b. All reinforcements shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer. If welding is approved, the work shall be carried out as per IS: 2751 according to the best modern practices and as directed by the Engineer. In all cases of important connections, tests shall be made to prove that the joints are of full strength of bars welded. Special precautions, as specified by the Engineer, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

9.4 SUBMITAL OF DRAWINGS AND SAMPLES:

D rawings:

The Engineer will supply detailed drawings of reinforced concrete works. Working drawings and bar bending schedules shall be prepared by the Contractor from the drawings supplied to him by the Engineer.

Sa mples:

At least one month in advance of placing an order by him, the Contractor shall submit four samples of reinforcing bars which he intends ordering in case, the steel is to be supplied by the Contractor.

The method of sampling shall conform to IS: 10790 Part 2 – 1984. The Engineer may carry out any test he may require to satisfy that the steel to be brought by the Contractor complies with the test Specifications.

9.5 LAPS AND SPLICES:

Laps and splices for reinforcement shall be as per IS: 456 – 2000. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the approved Drawings, shall be only as approved by the Engineer. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

9.6 D OWELS:

Where and as designated on the drawings, steel bar dowels shall be provided for anchorage to previously cast concrete.

For anchorage where shown or required to existing construction, an approved non-shrink epoxy type grout or approved bolting devices shall be used.

9.7 BENDING:

- a. Reinforcement bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done cold and without damaging the bars.
- b. All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings / bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and in a manner that will injure the material; bars containing cracks or

splits shall be rejected. They shall be bent cold, except bars over 25 mm in diameter which may be bent hot if specifically approved by the Engineer. Bars, which depend for their strength on cold working, shall not be bent hot. Bars bent hot shall not be treated beyond cherry red colour (not exceeding 845 degree C) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and rebending be such as shall not, in the opinion of the Engineer, injure the material. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

9.8 FIXING:

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position by the use of blocks, spacers and chairs, as per IS: 2502, to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

The Contractor shall ensure that all reinforcing bars are thoroughly wire brushed and cleaned free of loose mill scale, loose rust, coats and paints, oils, mud or other coating.

Mesh reinforcement, where specified shall conform to IS: 1566 – 1982.

Binding wire shall be annealed wire conforming to IS: 280.

9.9 COVER:

Unless indicated otherwise, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish) shall be as follows:

- (i) At each end of a reinforcement bar, not less than 25mm nor less than twice the diameter of the bar.

- (ii) For a longitudinal reinforcing bar in a column not less than 40mm, nor less than the diameter of the bar. In case of columns of minimum dimension of 20cm or under with reinforcing bars of 12mm and less in dia. a cover of 25mm may be used.
- (iii) For longitudinal reinforcing bars in a beam, not less than 25mm nor less than the diameter of the bar.
- (iv) For tensile, compressive, shear or other reinforcement in a slab, or wall, not less than 15mm, nor less than the diameter of such reinforcement.
- (v) For any other reinforcement, not less than 15 mm, nor less than the diameter of such reinforcement.
- (vi) For footing and other principal structural members in which the concrete is poured on a layer of lean concrete, the bottom cover shall be minimum of 50mm.
- (vii) For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and tops, etc. not less than 50mm for bars larger than 16mm diameter and not less than 40mm for bars 16mm diameter or smaller.
- (viii) Increased Cover thickness shall be provided for surfaces exposed to the action of harmful chemicals or exposed to earth contaminated by such chemicals acids, alkalis, saline atmosphere, sulphurous smoke etc. and such increase of cover may be between 15 mm and 50 mm beyond the figures mentioned here as may be specified by the Engineer.
- (ix) For liquid retaining structures, the minimum cover to all steel shall be 40 mm or the diameter of the main bar, whichever is greater. In the presence of soils and waters of a corrosive character, the cover shall be increased by 10mm.
- (x) The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footing, grade beams and slabs on sub grade shall be

supported on precast concrete blocks as approved by the Engineer. The use of pebbles or stones shall not be permitted.

(xi) The 28 day crushing strength of cement mortar cubes / pre cast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes / blocks are embedded.

(xii) The minimum clear distance between reinforcing bars shall be in accordance with IS: 456.

9.10 INSPECTION:

All continuous inspections shall be performed by the Engineer's Representative. Erected and secured reinforcement shall be inspected and approved by the Engineer prior to placement of concrete.

9.11 REINFORCEMENT BARS PROCUREMENT:

Steel reinforcement, such as M.S. bars, High yield strength deformed bars etc., required for the works shall be procured by the Contractor. The Contractor shall arrange for transport, loading, unloading and storage at the work sites. The Contractor should plan the procurement of steel in such a way that at least required quantity of steel of specified sizes is available at site for 3 months period.

In case Board supplies steel, the carting from Board stores to work site is included in the item. Reinforcement shall be transported stacked and stored at site away from soil contact and protected from rain so as not to damage or rust the material. The bars shall be stored above ground surface upon platforms or supports to avoid distortion and sags of long length.

The rate quoted for steel reinforcement shall be inclusive of taxes, transport incidental charges etc., apart from labour component as specified in the respective item in the Bill of Quantities.

Steel brought on site shall be stored in a proper manner as approved by the Engineer so as to avoid distortion, deterioration and corrosion. The Contractor shall maintain proper registers for the steel account, showing the steel received at site, steel used, and the balance stock on site, to the entire satisfaction of the Engineer. Further, it

shall be obligatory on the part of the Contractor to submit monthly, quarterly and yearly statements giving the full account of steel on the works and the balance on hand.

9.12 ANTI CORROSIVE TREATMENT FOR REINFORCEMENT:

9.13.1 The item covers providing fusion bonded epoxy coating not less than 175 microns thickness and up to 300 microns to reinforcement steel bars of all diameters as per IS Code 13620-1993 for RTS rods for RCC works including testing of coating at plant.

CHAPTER 10 - PLASTERING

10.1 DEFINITIONS:

- a) The term “plastering” shall cover all types of rough or fair finished plastering, rendering, floating and setting coat or finishing coat, screed, etc., in mud, lime, cement lime or cement mortar.
- b) “Dubbing out” shall mean filling in hollows in the surface of wall and roughly levelling up irregular or out of plumb surfaces, prior to rendering.
- c) “Rendering” or “rendering coat” shall mean the plaster coat, which is applied following the “Dubbing out” or the final coat in case of one coat work.
- d) “Floating coat” shall mean the second coat in a three-coat plasterwork, to bring the rendering coat to a true and even surface before the setting or finishing coat is applied.
- e) “Setting of finishing coat” shall mean final coat in a two or three coat plaster work.
- f) “Thickness of plaster” shall mean the minimum thickness at any point on a surface. This does not include thickness of dubbing out.
- g) The term “even and fair” as referred to finishing of the plastered surface shall mean a surface finished with a wooden float.
- h) The term “even and smooth” as referred to finishing of the plastered surface shall mean a surface levelled with wooden float and subsequently smoothed with a steel trowel.

10.2 SC AFFOLDING:

Where possible, independent scaffolding shall be used to obviate the subsequent restoration of masonry in putlog and other breaks in the work. Stage scaffolding shall be provided for ceiling plaster.

10.3 PREPARATION OF MORTAR FOR PLASTERING:

10.3.1 Materials:

Cement Mortar:

Cement mortar shall have the proportion of cement to sand as mentioned in the item or in the special provisions and shall comply with following:

Cement:

Cement shall conform to IS: 12 269 - 1987 Ordinary Portland Cement shall be used. The weight of ordinary Portland cement shall be taken as 50 kg. per bag. The Contractor shall ensure that the cement is of sound and required quality before using it. Any cement, which has deteriorated, caked or which has been damaged shall not be used. The Specifications covered under the section brickwork and concrete work shall be applicable in addition.

Water:

Water shall be clean, clear and free from injurious quantities of salt, traces of oil, acids, alkalis, organic matter and other deleterious materials. The sources of water shall be approved by the Engineer and the containers for conveyance; storage and handling shall be clean. If necessary, standard cement tests shall be conducted using the water intended to be used, in comparison with those adding distilled water to check quality of water.

Water shall meet the requirement of 4.3 of IS: 456 – 2000. Generally potable water is fit for mixing and curing.

Fine Aggregate:

All fine aggregate shall conform to IS: 383 – 1970 and relevant portion of IS: 515 –1959.

Sand shall be clean, well graded, hard, strong, durable and of gritty particles free from injurious amounts of dust, clay, kankar nodules, soft or flaky particles, shale, alkali, salts, organic matter loam mica or other deleterious substances and shall be approved by the Engineer. The maximum size of particles shall be limited to 5 mm. If the fine aggregate contains more than 4 percent of clay, dust or silt, it shall be washed.

The fine aggregate for cement mortar for masonry and first cost of plaster should generally satisfy the following grading:

I.S. Sieve	Percent by wt. Passing sieve
4.75mm 10	0
2.36mm 80	-95
1.18mm 70	-90
600microns 40	-85
300microns 5-5	0
150microns 0-1	0

The fineness modulus shall not exceed 3.00.

The fine aggregate for cement mortar for fine joints of ashlar masonry, pointing and second coat of plaster may have the following grading:

I.S. Sieve	Percent by wt. Passing sieve
4.75mm 10	0
2.36mm 10	0
1.18mm 75	-100
600microns 40	-85
300microns 5-5	0
150microns 0-1	0

The fineness modulus shall not exceed 1.6.

IS: 2116 – 1980 shall generally apply for sand for plaster. The fine aggregate should be stacked carefully on a clean, hard surface so that it will not get mixed up with deleterious foreign materials.

10.3.2 Proportion:

Cement and sand shall be mixed in specified proportions, sand being measured in measuring boxes. The proportions will be by volume. The mortar may be hand mixed or machine mixed.

10.3.3 Preparation:

In hand mixed mortar, cement and sand in the specified proportions shall be thoroughly mixed dry on a clean impervious platform. Fresh and clean water as specified above shall be added gradually and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement.

The water cement ratio may be as under or as directed by the Engineer.

Cement Sand	nd	Water – Cement ratio	Quantity of water per 50 kg. of cement (Litres)
1 1		0.25	12.5
1 1	½	0.28	14.0
1 2		0.30	15.0
1 2	½	0.35	17.5
1 3		0.40	20.0

1 4		0.53	26.5
1 5		0.60	30.0
1 6		0.70	35.0
1 8		0.90	45.0

Machine mixed mortar shall be prepared in an approved mixer. Water cement ratio shall be as per hand mixed mortar. The mortar so prepared shall be used within 30 minutes of adding water. The mortar remaining unused after that period, mortar, which has partially hardened or is otherwise damaged shall not be re tempered or re mixed. It shall be destroyed or thrown away.

10.4 PREPARATION OF BACKGROUND FOR APPLICATION OF PLASTER:

C leanliness:

All dirt, dust and other foreign matter on masonry and laitance on the concrete surfaces shall be removed by watering and brushing as required. If the background contains soluble salts particularly sulphates, the application of plaster shall be done only after the efflorescence of the salts is complete and the efflorescence is completely removed from the surface.

Joints in brickwork, stone masonry and hollow block, masonry shall be raked out to a depth of not less than 10mm as the work proceeds. Local projection in brickwork and masonry beyond the general wall face shall be trimmed off where necessary.

Roughness:

Smooth surfaces of in-situ concrete walls and ceilings etc. shall be roughened by wire brushing, if it is not hard; and by hacking or bush hammering if it is hard, to provide for proper adhesion. Projecting burrs of mortar because of gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surface shall be pock marked with a pointed tool at spacing of about 50mm, the pocks made to be not less than 3mm deep.

Suction Adjustments:

Adequate drying intervals shall be allowed between the erection of masonry and plastering to bring the surface suitable for suction adjustment. High rate of suction makes the plaster weak, porous and friable. The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry in spots, such areas shall be moistened again to restore uniform suction. Excessive water leads to failure of bond between the plaster and the background.

Evenness:

Any local unevenness must be leveled and projections removed to avoid variance in the thickness of plaster.

Immobility:

Differential movements between the background and the plaster due to moisture change, temperature change, structural settlement, deflection, etc. cause cracks. The major part of such movements shall be allowed to set in before the plaster is applied.

10.5 PLASTERING:**Plastering Generally:**

The type and mix of mortar for plastering, the number of coats to be applied, the surface finish of the plaster and the background to which the plaster is to be applied shall be as indicated.

The mortar for dubbing out and rendering coat shall be of the same type and mix. Dubbing out may be executed as a separate coat or along with the rendering coat.

Protection:

All existing work and fittings that are likely to be damaged in the application of plastering shall be protected. Care shall be taken to avoid, as far as possible, the splashing of mortar on to the finished surfaces such as joinery, paint work and glazing; all such splashes shall be cleaned off immediately.

Screeds 15 x 15cm shall be laid vertically and horizontally not more than 2 m apart to serve as guides in bringing the work to an even surface.

Plastering shall be done from top to bottom and care shall be taken to avoid joints in continuous surface.

Maintenance of proper time intervals:

To avoid break down of adhesion between successive coats, drying shrinkage of first coat shall be allowed to be materially completed before a subsequent coat is applied.

All corners, arises, angles, junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering of corners, arises and junctions shall be carried out with proper templates to the required size. Plastering of cornices, decorative features, etc. shall normally be completed before the finishing coat is applied.

In suspending the work at the end of the day, the plaster shall be cut clean to the line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scraped clean and wetted with lime putty or cement slurry before plaster is applied to the adjacent area.

Partially set and dried mortar shall not be retempered for use.

Cleaning of completion:

On completion, all work affected by plastering and pointing shall be left clean, special care shall be taken when removing any set mortar from glass and joinery, etc. to avoid damaging their surface.

10.6 ONE COAT PLASTER WORK:

Mortar shall be firmly applied to the masonry walls and well pressed into the joints and forcing it into surface depressions to obtain a permanent bond. The plaster shall be laid in a little more than the required thickness and levelled with a wooden float. On concrete walls, rendering shall be dashed on to roughened surface to ensure adequate bond. The dashing of rendering coat shall be done using a strong whipping motion at right angles to the face of walls. The surface shall be finished even and fair. Unless indicated to be finished even and smooth.

10.7 TWO COAT PLASTER WORK:

First Coat:

The first coat of the specified thickness shall be applied in a manner similar to one coat plasterwork. Before the first coat hardens, the surface of the cement and cement lime plasters shall be scored to provide key for second coat. In case of lime plasters the surface shall be beaten with edges of wooden thapies and close dents shall be made on the surface, to serve as a key to the subsequent coat. The rendering coat shall be kept damp for atleast two days, it shall be allowed to become thoroughly dry.

Second Coat:

Before starting to apply second coat, the surface of the rendering coat shall be damped evenly. The second coat shall be completed to the specified thickness in exactly the same manner as the one coat plaster work.

10.8 NE ERU FINISH:

After applying and finishing the undercoats and before they set, the finishing coat of specially prepared lime putty about 1.5 mm thick shall be applied. It shall be well polished with a trowel.

10.9 SAND FACED PLASTER:

After the undercoat of cement and sand mortar 1:4 not less than 10mm thick, has been applied and finished, the final coat of cement and sand mortar 1:4 shall be applied to a thickness not less than 5mm and brought to an even surface with a wooden float. The surface shall then be tapped gently with a wooden float lined with cork to retain a coarse surface texture, care being taken that the tapping is even and uniform.

10.10 CURING:

Each coat shall be kept damp continuously for at least two days. Moistening shall commence as soon as the plaster has hardened sufficiently and is not susceptible to injury. The water shall be applied preferably by using a fine fog spray. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. Excessive evaporation on the sunny or windward sides of buildings in hot dry weather shall be prevented by hanging matting or gunny bags on the outside of the plaster and keeping them wet.

After the completion of finishing coat, the plaster shall be kept wet for at least seven days and shall be protected during that period from extremes of temperature and weather.

10.11 WATER PROOFING PLASTER:

Integral water proofing compound shall be mixed with cement in the proportion indicated by weight. Care shall be taken to ensure waterproofing material gets well and integrally mixed with cement and does not run out separately when water is added.

CHAPTER 11 GLAZED STONEWARE PIPES

11.1 MATERIALS:

The Glazed Stoneware Pipes shall conform to IS: 651 – 1992

11.2 QUALITY:

All pipes shall be sound and free from visible defects which impair the strength, durability and serviceability. The glaze of pipes and fittings shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer. Colour of pipes/fittings may vary from yellow to dark brown/black.

11.3 GLAZING:

The interior and exterior surfaces of the pipes which remain exposed after jointing, shall be glazed. The portion which remains covered after jointing may or may not be glazed. The glaze shall be obtained by the action of fumes of volatilized common salt on the material of the pipes during the process of burning.

11.4 INTERNAL DIAMETER

The internal diameter of the barrels of straight pipes, junctions and bends shall be as specified in column 1 of Table 1 in IS-651-1992.

11.6 LENGTH AND STRAIGHTNESS OF BARRELS OR STRAIGHT PIPES

The length of the barrel of the straight pipes exclusive of internal depth of the socket shall be 600mm.

11.5 GROOVING

The interior of the sockets and exterior of the spigots shall be grooved circumferentially, and such grooving on the spigot shall be for a length equal to one and half times the depth of the socket, and depth of such groove shall be between 1mm to 25mm.

11.6 MARKING:

Every pipe and fitting shall have legibly impressed upon it the following:

- a) Name or trademark of the manufacturer, and
- b) Size (Internal Dia).

Each pipe may also be marked with the Standard Mark.

11.7 TESTS

11.7.1 Testing Facilities

The manufacturer shall, at his premises and at his own cost, provide the necessary gauges, supply and prepare all test pieces and supply all labour and apparatus for testing which may be necessary for carrying out the tests as required by IS standard: 651-1992.

11.7.2 Hydraulic Test

When subjected to the hydraulic test, straight pipes shall withstand an internal hydraulic test pressure of 0.15 MPa on the barrels without showing signs of injury or leakage. The pressure shall be applied on pipes at a rate not exceeding 0.075 MPa in 5 seconds, and full pressure shall be maintained for at least 5 seconds. Care shall be taken to ensure that all air is expelled before the test is commenced.

11.7.3 Absorption Test

Pipes shall be tested for absorption in accordance with the procedure given in Clause 7.3 of IS:651 - 1992.

11.7.4 Test for Acid Resistance

Pipes shall be tested for acid resistance with hydrochloric or nitric or sulphuric or acetic acid in accordance with the procedure given in Annex A of IS:651 - 1992. The loss in mass shall not exceed 0.25 percent.

11.7.5 Test for Alkali Resistance

Pipes and fittings shall be tested to the action of magnesium sulphate in accordance with the procedure given in Annex B of IS:651-1992. There shall be no evidence of pitting, softening, spalling or cracking in the pipe or fitting after the test.

11.7.6 Crushing Strength Test

When tested along the full length of the pipe barrel from shoulder to spigot in accordance with Annex C, the pipe tested shall have a minimum crushing strength of 16 k N/m length.

CHAPTER – 12 LAYING & JOINTING OF STONEWARE PIPES

12.1 General

The Work will be set out by the Engineer who will give proper lines, positions, level, depths and particulars on the ground. The Contractor shall provide poles, rails, boning rods straight edges, struts, pegs, etc. and all labour for fixing the same. The Contractor must check and satisfy himself of the accuracy of the finished accuracy of the work in accordance with the contract. The Contractor shall take every care that the pegs or pillars for levels or lines are carefully preserved, from disturbances. Should he neglect this precaution the cost of re-setting shall be borne by him.

12.2. Sight rails and boning rods

The Contractor shall be required to fix over the centre of each manhole or where a change in direction or gradient occurs a strong timber sight rail, 150mm x 25mm with top edge placed straight and true. These shall be supported and fixed to stout wooden posts at each side of the excavation. The centre line of the sewer shall be marked on each sight rail both back and front by the single vertical line drawn thereon and on other side white. All lengths of sewer shall have three sight rails fixed one at each end and one in the centre and worked one with the other. The boning rods shall have a movable cross head at right angles to the rod so arranged that it can slide up and down the rod and capable of being fixed at any required position on the rod by screws. The foot of the boning rod shall be provided with a shoe made truly at right angles to the rod so that when placed on the pipe being laid it shall rest properly on the pipe when the rod is truly vertical.

12.3. Laying stoneware pipes other than concrete

Before laying the pipes, the Contractor shall carefully brush them to remove any soil, stores or other materials which may be therein, even and regular bed having been prepared, and joint pit excavated to form a recess under the socket of each pipe of no greater width and depth than to enable the pipe joining to be properly done, each pipe shall then be carefully lowered and placed singly in the trench and shall rest on the solid ground for a distance of not less than two thirds of its entire length.

Each pipe shall be brought in to a true line from manhole to manhole, for this purpose, a strong twine line (rat thread) sufficiently long to reach the full length between manholes shall be used. Each pipe shall be set correctly to level by means of the boning rod and sight rails.

The spigot of each pipe shall be carefully wrapped with a ring of spun yarn dipped in cement grout or tarred gasket sufficiently thick to properly fit the socket of the adjoining pipe and to allow true alignment. The pipe shall then be driven fully home into the socket of the adjacent previously laid pipe and yarn or tarred gasket carefully driven home with a caulking tool.

The remaining space in the socket shall then be tightly and completely filled with cement mortar composed of one part of Portland cement and one and a half parts sand and shall be nearly bevelled off around the circumference and finished at an angle of 45 degrees outside the socket of the pipes. A wooden caulking tool shall be used for forcing the mortar into the sockets.

A tightly fitting bag of shavings or straw having a rope attached shall be drawn through the pipes as the work proceeds to ensure that there is no cement or yarn or other obstruction projecting into the interior.

All joints shall be kept moist either by means of wet bags, wet clay or wet earth whichever may be ordered by the Engineer to protect them from the sun. Such covering shall be removed when the length is tested for water tightness.

12.4. Laying stoneware pipes on concrete

In trenches where ordinary socket and spigot stoneware pipes are to be laid on concrete, the method to be adopted is as follows.

When the earth is taken out to the proper depth and gradient, a concrete bed of suitable thickness and width is to be laid as directed by the Engineer. The top of this concrete bed shall be to the required gradient.

When the concrete has set sufficiently, a series of special concrete invert blocks are to be laid about 60 cm apart and levelled so that their top surface may be exactly the level of the sewer invert, less the thickness of the pipes. The correctness of level of the pipes is to be ascertained by working a straight edge from the invert of each pipe to block ahead. The pipe must also be checked at intervals for the proper line and level and the first pipe of any length must be very carefully bedded and levelled into position.

The object to be obtained by the method above described is to ensure that the outside of the sockets shall be raised approximately 25mm above the concrete bed in order to allow the joints to be made properly in the under side.

In his prices for laying concrete, the Contractor must allow for doing the work in the manner as above described including cost of blocks.

12.5 Concreting Pipelines

The bedding for different sizes of RCC pipes shall be with sand as per specifications No.7 of Tamil Nadu Building Practice (TNBP).

The concrete encasing (2/3rd Bottom) is to be provided for SW pipes to be laid at a depth from 2.5m to 3.0m. The bedding for different sizes of SW pipes shall be with M-15 Concrete as per IS code. The minimum earth cover for all the pipes to be laid shall be not less than 0.8m.

12.6. Junctions on stoneware pipes

Where shown on the drawings or where directed by the Engineer Junction pipes shall be provided at intervals during the construction of sewers, the jointing being effected in a similar manner to the pipes of the sewer in which they are placed.

These junction arms shall be closed with stoneware or cement discs and the sockets filled with cement mortar. The trench shall not be filled in until the position and orientation of each junction has been measured and recorded by the Engineer.

12.7. Cleaning out Sewers and Manholes

During the whole of the work the Contractor shall keep interior surface of sewer and manholes free from cement mortar, bricks, soil or other superfluous matters and shall hand over the sewers perfectly clean and free from deposit on completion.

12.8. Water Test of Sewers

All sewers shall be tested before the filling in of the trench or other excavations. Testing shall also be done after refilling of the trench or other excavations, if considered necessary by the Engineer. The testing or re-testing shall be carried out by and at the expense of the Contractor who shall also provide the necessary appliances and water for the same. The tests will only be made from manhole to manhole after the manholes connected with the length under test have been completed finished.

The test shall be carried out in the following manner.

The pipes shall be carefully cleared of all earth or materials that may be lying thereon or therein and all joints shall be exposed right round so that thorough examination may be made whilst the pipes are under test.

The ends of the pipe shall be closed by means of expanding stoppers and all junctions with stoneware stoppers or cement disc fixed in cement mortar.

The last but one pipe at the higher end of the length shall be a junction pipe with the junction arm at the top which will permit of the filling of the length with water and also allow the escape of all air in the pipes.

The expanding stoppers at each end of the length under test shall have a hold in the centre with a small piece of a pipe screwed therein and threaded on the projecting pipe to permit of a flexible tube not less than 2m long fixed thereto by a coupling. At the end of the flexible tubing, the following shall be fixed.

- a. at lower end of length, a cock,
- b. at top end of length, a funnel of 15cm diameter.

The top of the funnel shall be fixed rigidly at a height of 30cm above the ground level, or such other height as may be decided by the Engineer.

After the above mentioned expanding stoppers have been fixed together with flexible tubing and funnel, the length shall then be filled with water through the junction arm of the pipe provided therefore. As soon as the water has risen to the level of the filling junction arm an expanding stopper shall be fixed thereon. After a short time has been allowed for absorption, water shall be poured into the funnel until the same is filled to the top.

If any of joints are leaking or if during a period of ten minutes the water level in the funnel drops 25 mm or more (no more water being added or sewer interfered with in anyway during the period) the test shall be considered unsatisfactory. If the water does not drop more than 25 mm and there is not sign of leakage at any of the joints, the test shall be continued for one hour and at the end of the hour the pipe lines including the joints shall be examined and, if no indication of sweating or leakage is found then the test will be considered satisfactory. Should the test be unsatisfactory, all such joints or pipes found to be defective shall be removed, replaced or repaired to the satisfaction of the Engineer by the Contractor at his cost.

The test shall be done as many times as may be necessary until the length is found to be watertight to the satisfaction of the Engineer.

The water required for testing shall be clean.

12.9. House Service Connections

The house service connection shall be effected at manhole doors only and upto boundary of premises (on road portion only) and do not require any specials except one stopper (100mm & 150mm dia).

12.10. Cleaning of Mains

During the whole of the Work the Contractor shall keep the interior surface of the mains free from cement, brick, soil or other superfluous matter and shall hand over the mains perfectly clean and free from deposit on completion.

CHAPTER 13 - DUCTILE IRON PIPES

13.1 MATERIALS:

D **uctile Iron:**

Ductile iron is an iron / carbon / silicon alloy, in which the carbon exists in a pure form as spherical graphite due to addition of small amount of magnesium to molten cast iron. The spherical shape of its graphite increases the mechanical properties such as tensile strength, toughness and ductility. The pipes manufactured by ductile iron shall conform to IS: 8329 – 2000.

Cement:

The cement used for internal cement mortar lining shall be ordinary Portland cement and shall conform to IS: 12330-1988 with its latest amendments.

Aggregate:

The aggregate shall conform to IS: 383 with its latest amendments.

Water:

The water used in the preparation of cement mortar mix shall conform to the requirements of mixing water given in IS: 456-2000.

R **ubber Gaskets:**

The Rubber Gaskets used for push-on joints shall conform to IS: 5382. Rubber ring bundles from every lot shall carry with them manufacturer's test certificate for the following mechanical properties.

- a) Hardness
- b) Tensile strength
- c) Compression strength
- d)) Oil immersion test
- e) Water absorption test
- f) Stretch test and visual examination

The test procedures, the scale of sampling and the criteria for acceptance shall be as per IS: 5382 and IS: 3400.

The Engineer or his representative shall at all reasonable times have free access to the place of manufacture for inspection and examining the test conducted by manufacturer.

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacture's name and trademark, the month and year of manufacture.

Rubber gaskets should be stored in a cool, dark place protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The rubber gasket should, whenever possible, be stored in a relaxed form free from tension, compression or any other deformation.

Rubber gaskets for use with flanged joints shall conform to IS 638.

13.2 CLASSIFICATION:

Pipes have been classified as K7, K8, K9, K10, K12, K14 depending on service conditions and manufacturing process. In the Bid document, the classes of socket spigot pipe considered are K7 & K9.

13.3 INSPECTION:

All works and materials under specification will be inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish materials and performed work in accordance with the specification.

The Contractor shall notify the Engineer, in advance of the production of materials and fabrication thereof, in order that the employer may arrange for mill and shop inspection.

The Engineer may reject any or all materials or works that do not meet with any of the requirements of these specifications. The Contractor shall rectify or replace such rejected material / performed work at his own cost to the satisfaction of the Engineer.

The Engineer shall have free access to those parts of all plants or any other premises and sites that are concerned with the furnishing of materials or the performance of work under this specification.

The Contractor shall furnish to the Engineer or his representative responsible facilities and space without charge for inspection, testing and obtaining of any information he desires in respect of the character of material used and the progress and manner of the work.

The Contractor shall furnish all the test results from an approved laboratory at any time during the progress of work to the satisfaction of the Engineer. The laboratory shall be approved by the Board.

13.4 MANUFACTURE OF D.I. PIPES:

The metal used for the manufacture of pipes shall be such that the pipes are of ductile iron complying with the metallurgical properties specified in IS: 8329. Therefore the manufacturer shall arrange good quality control system for selection of raw material. It shall be manufactured by any method at the discretion of the manufacturer, provided that the requirements defined in IS: 8329 are complied with. It is also essential that either the Contractor/supplier or the manufacturer should ensure that the manufacture of D.I. pipes and Specials should be fully covered by ISO 9000 certification.

The pipes shall be stripped with all precautions necessary to avoid warping or shrinkage defects. The pipes shall be free from surface or other defects. Pipes showing small imperfections which result from the method of manufacture and which do not affect their serviceability, shall not be rejected on that account alone. Minor defects arising out of manufacturing process may be rectified with the consent of the Engineer in charge.

Pipes centrifugally cast shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses in accordance with IS: 13655-1993.

If the specified mechanical properties and Brinell hardness are not as per the standard, the pipe may be subject to reheat treatment.

In case of push-on flexible joints, the spigot ends shall be suitably chamfered for smooth entry of pipe in the socket fitted with the rubber gasket.

In case of flanged pipes, the flanges shall be at right angle to the axis of the pipe and machined on the face. The bolt holes shall be drilled.

The bolt hole circle shall be concentric with the bore and the two flanges of the pipe shall be correctly aligned.

13.5 SAMPLING:

Sampling criteria for various tests, unless specified in the standard, shall be as laid down in IS: 11606 - 1986.

The material acceptance tests shall be carried out on ductile pipes grouped in batches as follows. Each batch shall be made up of pipes cast successively as under:

DN	80 to 250	200 pipes
DN	300 to 600	100 pipes
DN	700 to 1000	60 pipes

13.6 MECHANICAL TESTS:

Mechanical tests shall be carried out during manufacture. Test shall be conducted for every four hours of production. The results obtained shall be taken to represent all the pipes of all sizes made during that period.

13.7 DUCTILE IRON FITTINGS:

The fittings shall conform to IS: 9523 – 2000. The manufacture of fittings is similar to the Ductile Iron pipes and the mechanical properties of these fittings also similar to pipes.

13.8. TENSILE TEST:

Two test pieces obtained by cutting bars from spigot end of two pipes selected for testing when tested in accordance with the methods specified in IS: 9523 – 2000 shall satisfy the following requirements:

Nominal Diameter (Dn) mm	Type of castings	Tensile Strength Min, MPa	Elongation at Break Percent (Min)
All sizes	Fittings	420	5

13.9 BRINELL HARDNESS TEST:

For checking the Brinell hardness, the test shall be carried out on test bars cut from the fitting used for test conforming to IS: 1500 – 2005. The Brinell hardness shall not exceed 230 HB on the external unmachined surface.

13.10 HYDROSTATIC TESTS:

For hydrostatic tests, all fittings shall be kept under pressure for 15 seconds; they may be struck moderately with a 700-g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. As far as possible, hydrostatic test shall be conducted before coating the fittings.

13.11 WORKS AND INSTALLATION TEST REQUIREMENTS:

All pipes shall withstand hydrostatic test pressure at works as specified in the following Table:

Table: Hydrostatic Test Pressure For Pipes for K7 & K9 Class		
Nominal Diameter (Dn) (1)	Hydrostatic Test Pressure at works Mpa (as per IS 8329)	
	K₇	K₉
80 to 300	3.2	5.0
350 to 600	2.5	4.0
700 to 1000	1.8	3.2
1100 to 2000	1.2	2.5

All Fittings shall withstand hydrostatic test pressure at works as specified in the following Table:

Table: Hydrostatic Test Pressure For Fittings for K9 Class	
Nominal Diameter (Dn) (1)	Hydrostatic Test Pressure For Fittings Mpa (as per IS 9523)
Upto 300	6.0
350 to 600	5.0
700 to 1000	4.0
1100 to 2000	2.5

13.12 CEMENT MORTAR LINING:

The process of lining for D.I. pipes shall conform to IS 11906-1986 and IS 8329-2000 & IS 9523-2000 and its latest amendments.

13.13 MORTAR:

The mortar of the lining shall be composed of cement, sand and water.

Additives may be used, provided that they do not prejudice the quality of the coating and that of the transported water and that the lining remains in accordance with all the requirements of International Standard.

The mortar shall be thoroughly mixed and shall have consistency, which results in a dense and homogeneous lining.

The mortar shall contain by mass at least one part of cement to 3.5 parts of sand.

13.14 CONDITION OF THE INTERIOR SURFACE OF THE PIPE BEFORE APPLICATION OF THE LINING:

All foreign bodies, loose scale or any other material, which could be detrimental to good contact between the metal and the lining, shall be removed from the surface to which the lining is to be applied. The inner surface of the pipe shall also be free of any metal projections likely to protrude beyond 50% the thickness of the lining.

13.15 APPLICATION OF THE LINING:

The mortar of the lining is cast centrifugally inside the pipe. Apart from the inner surface of the joint, the parts of the pipe coming into contact with the transported water shall be entirely covered with mortar.

The mortar shall be free of any cavities or visible air bubbles and care shall be taken to ensure maximum density at all points. The consistency of the mortar, the time required and the speed of centrifuging the pipe shall be controlled so that segregation of the sand in the lining is reduced to a minimum.

Once centrifuging is finished, the lining shall be cured at temperatures greater than 4°C. Any loss of water from the mortar by evaporation shall be sufficiently slow that hardening is not impeded.

Repairs to damaged or defective areas are allowable. The damaged mortar shall first be removed from these areas. Then the defective part shall be repaired by using a trowel with fresh mortar so that a continuous lining having a constant thickness is again obtained.

For the repair operation, the mortar shall have a suitable consistency; if necessary, additives may be included to obtain good adhesion against the side of the existing undamaged mortar.

13.16 THICKNESS OF THE LINING:

The normal thickness of cement mortar lining shall not be less than for various size of pipes as shown below:

Diameter DN (mm)	Lining Thickness (mm)
80 – 300	3
350 – 600	5
700 - 1200	6

Thickness of lining shall be checked frequently as the Engineer may direct in order to maintain proper control on the lining operations. Graduated needle or other approved appliance shall be used for measuring the thickness. The tolerance in the lining thickness shall be +3mm and no minus tolerance is allowed.

13.17 SURFACE CONDITION OF THE HARDENED LINING:

The surface of the cement mortar lining shall be uniformly smooth. Only isolated grains of sand are allowed to appear on the surface of the lining.

The lining shall be free from corrugations or ridges that could reduce the thickness of the lining to less than the minimum value at one point, as specified in the above table.

On contraction of the lining, the formation of cracks cannot be avoided. These cracks, together with other isolated cracks, which may result from manufacture or may develop during transportation, are acceptable up to a width of 0.8mm.

The structure of the lining is related to the centrifuging process.

On the inner surface of the lining, a thin layer of the sand and cement is formed which may extend up to approximately one quarter of the total thickness of the mortar.

The manufacturer shall take maximum care in keeping the internal surface of pipe even and uniformly smooth. The check of unevenness of pipe shall be done as per IS 11906 - 1986.

CHAPTER 14 - LAYING AND JOINTING OF D.I. PIPES

14.1 TRANSPORTATION:

The transportation of materials to work site and stacking shall be done in such a manner as to cause minimum inconvenience to the traffic and other construction works. Pipes shall be protected during handling against impact, shocks and free fall to avoid cracks and damage. Pipes shall be loaded for transportation in such a way that they are secured and no movement can take place on the vehicle during transit. The same care shall be taken if pipes are transferred from one vehicle to another, however short the journey may be. The cement mortar lining of pipes that are damaged during transportation is to be repaired by hand application if possible; otherwise it has to be rejected. The decision for rejection shall be taken by the Engineer in charge.

14.2 UNLOADING OF PIPES:

Each pipe consignment shall be inventoried and inspected with care upon arrival even though the pipes have been inspected and loaded with care at the factory. Overall examination shall be made during unloading to ensure that the pipes have reached destination in good condition. If there is any sign of rough treatment on the coating, each pipe shall be inspected for damage.

While unloading, pipes shall not be thrown down from the truck to the hard roads. Cranes or Mechanical equipment shall be used for unloading the pipes from the truck. If mechanical equipment is not available, care should be taken to unload the pipes on timber skids. Unloading them on timber skids without a steadying rope and thus allowing the pipe to bump hard against one another should not be allowed. In order to avoid damage to the pipes specially to the spigot end, pipe should not be dragged along concrete and similar pavements with hard surfaces.

The pipes shall be laid on timber battens and secured with wooden wedges. The pipes shall be stacked with each tier at right angles to the preceding tier.

14.3 LOWERING OF PIPES AND FITTINGS:

The pipes shall be lowered cautiously to prevent disturbances of the bed and sides of the trench.

Proper implements, tools and facilities satisfactory to the Authority shall be provided and used for the safe and convenient execution of the work. All pipes, fittings,

valves and hydrants shall be carefully lowered into the trench, piece by piece, by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to pipes materials and protective coatings and linings. Under no circumstances shall pipes materials be dropped or dumped into the trench. Pipes over 300mm diameter shall be handled and lowered into trenches with the help of chain pulley blocks or preferably by cranes. Tripod supports used for this purpose shall be regularly checked to prevent all risks of accidents.

14.4 CLEANING OF PIPES AND FITTINGS:

All lumps, blisters and excess coating material shall be removed from the socket and spigot end of each pipe. The outside of the spigot and the inside of the socket shall be wire-brushed and wiped clean and dry and free from oil and grease before the pipe is laid.

14.5 LAYING:

Laying of DI pipes and fittings shall conform to IS 12288-1987 and its latest amendments. Before lowering the pipe, the trench section shall be got approved from the Engineer in charge. Trenches are to be dug to the specified level / grade. Sufficient cushion shall be provided for protection from surface traffic, future changes in the ground elevation. The width of the trench shall be to the required specifications providing room for pipe laying operation, back filling, compaction etc., Trenches should be shored and braced when conditions so warrant.

The bottom of the trench shall form a continuous bed for the pipe. Where rock is encountered, trenches shall be dug deeper and then filled and compacted to grade with suitable bedding material. The Contractor shall have to provide and maintain sight rails and boning rods wherever required till the completion of work. The pipe shall be laid in reasonably dry condition and under no circumstances they shall rest on slushy bedding.

The pipes shall be lowered slowly into the trench by means of chain pulley block and tripod stand or with the help of ropes and suitable size of wooden bullies or with the help of cranes. They shall be brought to the required level by giving packing with wooden sleeper pieces and ultimately with well-consolidated hard murum if required. The chain pulley block and tripod stand must be approved from the Engineer in charge. Under no circumstances pipe shall be allowed to be thrown in the trenches.

At the end of each day, the end of the pipe should be plugged to prevent entry of rodents, foreign substances, water etc.

14.6 SUPPORT OF PIPE FOR NALLAH / RIVER CROSSING:

Venteak piles are proposed for portion of pipeline which crosses the nalla / river or slushy soils. Each pipe shall be supported on a pair of Venteak piles driven up to 3.50m or firm ground whichever is met earlier.

One pair of timber piles shall be driven about 150mm behind the shoulder of toe socket and another pair about 750mm in front of the spigot end of the pipe.

The size of timber section to be used for Venteak piles shall be:

100mm x 100mm for pipe sizes upto 300mm

150mm x 150mm for pipe sizes above 300mm

A cross piece of section same as that of pile shall be bolted to a pair of piles which have been driven to the required depth.

The level of the cross piece should be such that when the pipe rests on its top, its Invert level coincides with the proposed invert of the pipe.

The pipe shall be aligned for straightness and secured in position by wooden wedges nailed down to the wooden cross piece.

The spigot end of each pipe shall be thoroughly homed in to socket of preceding pipe and jointing made.

The pipe shall be further secured from moving upwards by timber crosspieces bolted to the supporting piles. The section of the crosspiece shall be same as that of pile.

The socket ends of all pipes shall face uphill irrespective of the direction of water flow. Any deviation either in plan or elevation of less than $1\frac{1}{4}$ deg. angle shall usually be effected by laying straight pipes round a flat curve, of such radius that rubber gasket shall not be disturbed in its place.

Wherever new pipes laid are to be jointed with existing pipeline, first pipe laying work of new pipes are to be completed. Jointing of new pipe line with existing pipe line has to be completed within a stipulated time as per the instructions of Engineer in charge to keep the distribution system ready to supply water to the city. No extra payment will be made for this time bound urgent work.

14.7 TESTING:

After laying and jointing, the pipeline must be pressure tested to ensure that the pipes and joints are sound enough to withstand the maximum pressure likely to be developed under working conditions. The Contractor shall submit for the Engineers approval, details of his proposed methods and programme for testing including details of test equipments and shall arrange for all tests to be witnessed by the Engineer or his representative. The Contractor shall provide all things necessary for carrying out testing and cleaning including water pumps, gauges, piped connections, stop ends, and all other temporary works.

Pipelines shall be properly completed and supported before being put under test. No testing will be permitted until ten days after thrust blocks and other holding down works have been completed. In addition to any tests of individual joints or other interim tests which may be specified elsewhere, the Contractor shall submit, all parts of the pipelines to a final test. Notwithstanding the foregoing, the Contractor may at any stage of construction, carry out such other tests as he considers desirable to check materials and workmanship on the pipeline but this shall not relieve the Contractor of his obligations to achieve successful tests under the contract.

All water required for testing and cleaning the pipelines shall be potable water and shall be provided by the Contractor at his cost. The test can be carried out by means of a hand pump or a pressure pump.

Pipelines shall be tested in lengths between valve pits or such lengths as the Engineer may direct or permit.

Fittings required for temporarily closing the openings in pipelines to be tested shall be properly designed for this purpose and shall be adequately strutted to withstand the pressure specified.

The completed pipeline may be tested in sections; the length of section should be decided by considering:

- (a) the availability of suitable water;
- (b) the number of joints to be inspected; and
- (c) the difference in elevation between one part of the pipeline and another.

The maximum length that can be tested in one operation shall be restricted to 500m and minimum length shall be 50m.

Where joints are left uncovered until after testing, sufficient materials should be backfilled over the centre of each pipe to prevent movement under the test pressure.

The Contractor shall make his own arrangements to procure necessary equipments, apparatus etc., required for testing and shall provide necessary labour for filling with water the length of pipes to be tested, fixing all apparatus and for carrying on the testing operations until the length of pipe, specials and connections are firmly passed by the Engineer. If the testing apparatus and equipments are available with the Board, they can be hired by the Contractor at usual conditions and charges.

The length to be tested shall be provided with two blank flanges fastened on the usual manner by collar bands and bolts to the end pipes or if the length to be tested shall have a sluice valve at each end, such blank flanges may be dispensed with.

The length of pipes to be tested shall first be filled in with water from a higher section of pipes already laid or with clean water obtained from a service connection, as the Contractor may arrange with the approval of the Engineer.

Before the actual testing pressure is applied, any air which has logged in the length of pipe to be tested shall be got rid of, by screwing on at the highest part of the length of pipes or temporary air valve, or by opening a temporary stop-cock or by other means as the Engineer may direct.

The test pressure shall not be less than 10 kg/cm².

Each pipeline or section thereof, shall be filled with water and all air removed. The pressure in the pipelines shall be raised steadily until the site test pressure is reached in the lowest part of the section. This pressure should be maintained, by pumping if necessary, for a period of not less than 1 hour. The pump should then be disconnected and no further water permitted to enter the pipeline for a period of 1 hour. At the end of this period, the reduced pressure in the pipeline should be measured, the original test pressure restored by pumping and the loss measured by drawing off water from the pipeline until the pressure has fallen to match the reduced pressure previously noted. The loss shall not exceed 0.02 litre per mm diameter per Kilometer per 24 hours for each bar of head applied. If the pipeline fails to pass the test, the faults shall be located and repaired and the pipeline retested until it passes the pressure test. All exposed pipe, fittings, valves and joints shall be visually inspected during the tests.

If the length of pipeline under test is found to be satisfactory and no leaks or sweating are found at the pipe joints or at the joints of specials and connections, then this length of pipeline will be passed by the Engineer.

But should any pipe, joint, special or connection be found to sweat or leak, Contractor shall make good at his cost such defective joints and the length of pipe line shall be re tested until all pipes, joints specials and connections are found to be satisfactory.

After satisfactory test, the Contractor shall remove water from the pipeline and clean it after testing at his own cost, without flooding adjoining areas.

Duration of Hydraulic Test:

The test is for 1 hour only. The rate of allowable leakage is given on per day basis. The leakage observed within one hour shall be converted to per day basis and compared with criteria given.

Maximum field test pressure for pipes with flexible joints:

Table – 1 on page 11 of IS :12288 is not applicable in this case as our test pressures are well below the maximum field hydraulic test pressures given in the table.

Allowance of test pressure for lower elevations:

As regards allowance for lower points, there is marginal level difference in levels, between 2 points in the section to be chosen for testing and hence the difference in pressure developed will be insignificant.

Saturation of pipe material:

As regards saturation of material, it is significant in case of RCC, PSC pipes for DI pipes it is insignificant. We are not clear whether the remark is aimed at saturation of inner CM lining. The adequate curing of the lining will take care of this. Also the duration of the test is long enough to discount such possibility.

14.8 INTERCONNECTION WORK:

The interconnection work between the existing main and the proposed main to be laid under this contract shall proceed from the new main to the existing main. Before actually proceeding with the interconnection work, the Contractor shall make ready necessary tools and plants required for the work at site, such as pump sets, shoring materials etc. He shall also keep ready at site necessary pipes, jointing materials, specials and valves required for the work. The Contractor shall keep necessary skilled workmen

of sufficient strength at site and once the work commenced, the entire interconnection work shall proceed without interruption by engaging labour for carrying out the work on a continuous basis both day and night till the work is completed. The work shall be executed as per programme drawn up by the Engineer and shall be completed within the time ordered by the Engineer, for each individual interconnection. The work shall be carried out under the direction of the Engineer from the beginning to end.

Laying of specials, valves (except straight pipes from the branch of the new main to the connecting point in the existing main) including conveying specials etc. from the stores or site of stacking, excavating, timbering, pumping out water from the trenches, lowering, aligning, jointing specials and valves, cutting the existing mains, dealing with water, inserting the necessary branches, jointing, testing, refilling etc. is included in the item of providing, laying and jointing D I / MS pipes. Any ancillary work either of Temporary or Permanent nature required for interconnection and not covered by schedules shall be executed by the Contractor at no extra cost.

14.9 FLANGED JOINTS:

Flanged joint should be made by painting the facing of the flange with white lead freely and bolting up evenly on all sides. A thin fibre of lead wool may be very useful in making the joints water tight where facing of the pipes is not true.

When packing must be used, it should be of rubber insertion three ply and of approved thickness. The packing should be of the full diameter of the flange with proper pipe hold and bolt holes cut out evenly on both the inner and outer edges. Where the flange is not full faced, the packing may be of diameter of the packing strip only, proper placing of the packing should be checked before another pipe is jointed on.

CHAPTER 15 - APPURTENANCES

15.1 GENERAL:

All valves shall be double-flanged valves of Indian manufacture and in the size range 50mm to 300mm conforming to IS: 14846 – 2000 or any other national standard equivalent or higher than the Indian Standards mentioned. The materials used in construction, the design and all other relevant features shall be such that the valves are entirely suitable for use of force mains. Valves shall be of suitable pressure rating which shall not be less than twice the normal operating pressure.

15.2 DESIGN:

The design of the valves will be such that erosion, cavitation, vibration and head loss (in the fully open position) shall be a minimum.

15.3 SLUICE VALVES:

Sluice valves shall generally conform to IS: 14846 - 2000. Valves should close with clockwise rotation of the hand wheel. The direction of closing should be marked on the hand wheel. Valves shall be flanged (flat faced) and drilling shall conform to IS: 1537.

15.3.1 MATERIALS OF CONSTRUCTION:

Body	-	C.I. to IS: 210 Gr. FG 200
Wedge	-	C.I. to IS: 210 Gr. FG 200
Seat Rings	-	Bronze / SS 304
Channel lining	-	Gun Metal
Shoe	-	Gun Metal
Spindle	-	SS A1S1 431

Parameters:

Quantity	-	As per Bill of Quantities
Size	-	As per Bill of Quantities
Rating	-	10 Bar (PN 1.0)

Shop Testing Witnessing:

- Seat leakage test - 10 bar (1.0 M Pa)
- Body Hydrostatic test - 15 bar (1.5 M Pa)
- Back Seat Leakage test- 15 bar (1.5 M Pa)

16.3.2 V ALVE BODIES:

a . Castings:

The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surface of casing which are not machined shall be smooth and shall be carefully filed to remove all foundry irregularities.

b. Forgings:

All major stress bearing forgings shall be made to a standard specification, which shall be submitted if required to the Engineer for approval before work is commenced. Forgings shall be subjected to non-destructive tests to detect flaws if any. Forgings shall be heat treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for such forging shall be submitted to the CMWSSB. The Executive Engineer or his inspector may inspect such forgings at the place of manufacture with a representative of the Contractor.

c. Workmanship:

Workmanship and general finish shall be of first class commercial quality and in accordance with best workshop practice.

All similar items of the valve and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall be accurate and to specified tolerances so that replacements made to manufacturer's drawings may be readily installed.

All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings.

d. Protective coating:

Protective coating shall comply with IS: 14846 - 2000.

15.3.3 LUBRICATION:

All the points where lubrication is needed, the Contractor shall furnish full details of the method to be employed. The supply of the requisite lubricating equipment and lubricants for commissioning and operating and maintaining the valves shall be furnished.

15.3.4 FLANGES:

Valves of sizes 80mm – 300mm shall have flat flanges as per IS: 1538 Part IV Table – I. The flange-to-flange distances shall be as per IS 14846.

15.3.5 JOINTING MATERIALS:

Each valve shall be supplied under this Contract, with all requisite joint rings, nuts, bolts and washers for making the joints on all the valves to be installed under this Contract. Jointing material between the connecting flanges shall conform to the relevant IS code. Unless otherwise specified bolting used for jointing exposed connections shall be of carbon steel, conforming to IS: 210 Grade 20 Grade B, with galvanized finish.

15.3.6 FACTORY TESTS:

All the valves shall be tested at the factory for smooth, trouble free operation and operating torque requirements by operating between fully open and fully closed position three times.

The hydrostatic tests shall consist of

Closed End Tests where valve is held on both sides. Each valve is subjected to three hydraulic tests.

- a. Wedge open and pressure applied for 5 minutes to the whole body of the valve pressure given in Section 19.4.
- b. Second Test shall be applied to one face with pressure given in Section 19.4.
- c. Third Test shall be similar to second, but pressure applied to the other side of the wedge with same pressure.

For valves having terminal position shall be subjected to open-end test.

Testing for valves from Foreign Manufacturers:

- i) Sampling: Each valve is recommended to be tested.

- ii) Testing and Inspection: For foreign manufacturer: The testing and inspection procedure in this case shall conform with respective equivalent code.

15.4. AIR VALVES

15.4.1 Constructional Features:

Double ball air valves shall be of the kinetic, double orifice type able to release air in small quantities under pressure and in large quantities during filling. They have to allow for large inflow of air during emptying. The type and locations shall be fixed according to the detailed design and after approval by the Engineer in charge. The valves shall have an integrated sluice valve. If required, they shall be installed on a flange welded on the MS pipe / special. The possible air velocity (inflow and outflow) must be at least 20 m/s.

Materials of Construction & Pressure Rating:

Body	CI to IS Gr. FG 200
Cowl	CI to IS Gr. FG 200
Valve seat, nut	Leaded tin bronze
Spindle	SS. AISI 304
Orifice	SS. AISI 304
Ball	Seasoned teak wood, covered with neoprene rubber
Ball seat	Anti-stick material such as nitrile rubber or equivalent
Pressure	Suitable for 16 Kg / sq.cm, Working Pressure.

15.5. REFLUX VALVES

15.5.1 Constructional Features:

Reflux valves shall comply with BS.5153 and be double flanged cast iron unless otherwise specified.

Valves shall be of the quick action single door type, designed to minimise slam on closure by means of heavy gunmetal-faced doors weighted as necessary. The valves shall be fitted with positively fixed renewable gunmetal door sealing faces. The door hinge pin/shaft shall extend through a sealing gland on the side of the body, and be fitted with an external lever to permit back flushing.

Gland shall be of the stuffing-box type with the exception that for valves below 450mm bore they may be of the 'O' ring type.

The valve door shall be weighted to suit the application and the lever shall be of the heavy duty type designed for the addition of external weights.

All reflux valves shall be suitable for operating in the horizontal plane unless otherwise specified.

Covers shall be provided to allow ample access for cleaning and service and shall be supplied complete with tapped bosses fitted with air release cocks.

Valves above 350mm, bore shall be provided with feet.

The design of the valve body shall be such that there is adequate clearance around and at the back of the door to minimise jamming by rags and debris. Stops shall be provided to limit the back life of the door, these shall be positioned to prevent fouling.

The hinge pin/shaft shall be stainless steel and square in section, to ensure positive location of the door. If circular shafts are utilised, the back flushing lever shall be located on a squared section, the diagonal dimension of which shall be equivalent to the full diameter of the shaft. Both door and lever shall be positively and securely fixed to the hinge pin/shaft. Grub screws, pins (parallel or taper) or clamps will not be acceptable. All internal fixing devices shall be of stainless steel.

Valves shall carry identification marks and/or plates in accordance with BS.5153.

Valves shall be sized, such that the velocity through the valve when fully open does not exceed 2.25 metres per second at the rated throughput. They shall have flanges to BS.4504 NP.16 and shall be capable of withstanding the same test pressures as the pipeline on which they operate. All nuts and studs subject to vibration shall be fitted with spring washers or locking tabs.

All materials used in the manufacture of reflux valves shall conform to the following minimum standards:-

Cast Iron	IS : 210	Grade FG 200
Gunmetal	IS : 318	Grade 2
Stainless Steel	IS : 6603	Grade 431S29

15.6. PENSTOCKS

15.6.1 General

Penstock shall be suitable for their application, the liquid being passed and shall be installed and positioned in such a manner as to allow ease of operation and maintenance.

Penstocks shall carry identification marks and/or brass plates in accordance with BS.5153 which identify the penstock number and function.

All penstock shall be clockwise closing.

All materials used in manufacture of the penstocks shall conform to the following minimum standards unless otherwise specified.

Cast Iron	BS 1452	Grade 220
Gunmetal	BS 1400	Grade LG25
Aluminium Bronze	BS 2872	Grade CA 104
Stainless Steel	BS 970 Pt.1	Grade 316 S31
High Tensile Brass	BS 2874	Grade CZ 114
(Manganese Bronze)		
Manganese Steel	B S 970 Pt.1	Grade ISOM19
Phosphor Bronze	BS 2574	Grade P13
Austenitic Ni resist		
Cast Iron	BS 3468	Grade F3 with 3% Nickel

Fixing nuts and bolts supplied by the manufacturer shall be of stainless steel.

Each penstock shall be provided with a suitable hand wheel of adequate diameter for the duty required. Gearing shall be supplied where necessary.

- i) To ensure that the required operating force applied by hand to the rim of the wheel does not exceed 25 Kgf.
- ii) If the hand wheel cannot be readily accessed, extension spindles, head stocks and foot brackets shall be provided where specified.
- iii) Where possible, the extension spindle shall be of the rising type with the threaded portion positioned above top water level.
- iv) Head stocks for non-rising spindle installations shall incorporate a position indicator.

Hand wheels shall have smooth rims and the direction of closing which shall be clockwise shall be cast on them. Vandal and weather proof clear polycarbonate tube covers shall be securely fitted to protect the threads of rising stems and spindles. Tubes shall be clearly and permanently engraved to indicate the position of the value.

Penstock spindles shall be forged aluminium bronze or stainless steel, machined all over, with a machine cut robust trapezoidal or square form thread, operating in a gunmetal nut.

Extension spindles shall be of stainless steel and shall be compliant with requirements for penstock spindles. Extension spindled couplings shall be of the muff type and shall be drilled and provided with a nut and bolt for securing the spindle to the penstock spindle, which shall likewise be drilled to accept the bolt.

Extended spindle in stallions of the rising type shall be provided for valves of 300mm bore and above, and for all motorised/actuated penstocks. Thrust tubes shall be provided between the Penstock frame and head stock to absorb the thrust in both directions of operation. Thrust tubes shall incorporate all necessary fixing brackets and spindle guide plates.

Where penstocks are required to be operated by tee keys, spindle caps shall be fitted. The caps shall be drilled and each provided with nut and bolt for securing to the spindle which shall likewise be drilled to accept the bolt. Where caps are fitted they shall be supplied complete with operating tee key. The extended spindle shall be such that the tee key will be operated at 0.9-1.2 metres above floor level.

15.7 MANHOLES

15.7.1 Manholes shall be constructed on the sewers in the positions shown in the drawings or in such position as the Engineer may direct. The work shall be done strictly in accordance with the detailed drawings except where alterations are required by the Engineer. The excavation shall not be larger than sufficient to admit of the trench being properly timbered and to facilitate plastering outside.

The bottom of the excavation shall be properly levelled up, rammed and a bed of concrete laid thereon. When the concrete has sufficiently set the construction of the brick walls shall then be proceeded with and all stoneware pipe connections through the walls shall be made and all ironwork fixed in as construction proceeds. Manholes less than 2.5m from invert of sewer to ground level shall be built rectangular and shall have a flat top constructed as shown in the drawings, Manholes more than 2.5m from surface to invert shall be built circular and the walls corbelled as shown in the drawings.

The inside of all manholes shall be plastered with cement mortar 20mm thick and the outside of all manholes with cement mortar 12 mm thick. The manhole bottoms shall be properly formed with stoneware channels fixed in cement mortar. The channels shall be neatly formed to the radius of the pipe and all side connection curved and channelled to admit the sewage to enter at an angle of 45 degree to the line of flow. Manholes shall be topped with a circular cast iron frame with cover or cover of such pattern may be ordered by the Engineer. The manhole frame shall be fixed to the top of the brick work by a layer of cement mortar.

15.7.2 Where pipes pass through walls of manholes relieving arches shall be turned neatly over the upper half of the pipes. If any pipe enters at such an angle that a relieving arch cannot be properly turned the bricks shall be carefully cut and laid so as to fit

closely and neatly against the pipe, and a R.C.C. lintel shall be provided to avoid load of the walls being transmitted to the pipes.

- 15.7.3 The stoneware drop pipe connection in manholes shall be secured to the wall of the manholes by suitable clamps and shall be built in as the work proceeds in accordance with the drawings and the above instructions. The cost of this work will be paid separately.
- 15.7.4 PVC encapsulated Cast Iron steps shall be built in each manhole as the work proceeds one being inserted to every four courses of brick work, horizontal distance centre to centre of each row being 300 mm.
- 15.7.5 The Contractor shall include in his prices for completing all manholes in accordance with the drawings.
- 15.7.6 The manhole shall be provided with heavy duty FRC manhole cover frame of size 600mm dia for rectangular and circular type manholes.

15.9 CHAIN PULLEY BLOCK

The Chain pulley block shall be of the following specifications:

Sl. No.	Description	
1.	Type	Manually operated Balanced Spur Gear type
2.	Duty Class	Class 11, IS:3832
3.	No of Hand Chain Falls	Endless
4.	No of Load Chain Falls	1
5.	Effort on Hand Chain to raise full working load For Bush Bearing type (kg)	51
6.	For Ball Bearing type (kg)	44
7.	Type of Load Brake	Ratchet & Pawl Arrangement
8.	Hand Chain Details	Through pocketed hand chain wheel guided by hand chain guard
9.	Load Chain size (d x p x w)	12.5 x 35.2 x 40
10.	Load chain material	Grade 40, IS:3109 (Part II)
11.	Hand Chain size (d x p x w)	6 x 26.5 x 21
12.	Hand Chain Material	Grade 30 as per IS:2429 (Part II) and IS: 3832

13.	Load Chain Material & Grade	Speriodal Graphite Iron, IS: 1865 400/15
14.	Hand Chain Wheel	Cast iron, Grade 25, IS: 210
15.	Gear	En9 /En8 - Case Hardened & Tempered
16.	Pinions	En32B - Case Hardened & Tempered
17.	Rate net Wheel	En 8 - Hardened, Tempered & Ground
18.	Hooks	Conforms to IS: 8610 (Material: Class II, IS:1875
19.	Frames	M.S. IS: 2062 Gr A

CHAPTER 16 - FIXING OF VALVES

16.1 FIXING OF SLUICE VALVES:

16.1.1 General:

The specification lays down the requirement for lowering, laying and jointing Sluice valves.

16.1.2 Preparation:

The sluice valves and tailpieces shall be examined before laying for cracks and other flaws. Only undamaged S.S. shall be used.

The sluice valve shall be operated and checked before laying. All grit and foreign material shall be removed from the inside before placing. All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease. The tightening of gland shall be checked with a pair of inside calipers. Clearance between the top of stuffing box and the underside of the gland shall be uniform on all sides.

16.1.3 Jointing Materials:

The Contractor shall provide all the necessary jointing materials such as nuts, bolts, rubber packing, white zinc, jute, lead wool etc. at his cost. All tools and plant required for installation of sluice valve shall be provided by the Contractor at his cost. All the jointing materials shall be got approved from the Engineer in charge before use. The nuts and bolts shall conform to IS: 1364 and the rubber packing shall conform to IS: 638.

16.1.4 Installation:

The sluice valve shall be lowered into trench carefully, so that no part is damaged during lowering operation. If necessary tailpieces shall be fitted with sluice valve first outside the trench and then lowered into the trench.

The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange, with necessary holes and the sluice valve bore. It shall be even at both the inner and outer edge. The flange faces shall be thoroughly greased. If flanges are not free the Contractor shall use thin fibres of lead.

After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

The valve shall be tightly closed being installed to prevent any foreign materials from getting in between the working parts of the valve.

Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternately.

The sluice valve shall be installed in such a way that spindle shall remain in truly vertical position. The other end of the tailpiece shall be fitted with pipes so that continuous lines can work. Extra excavation necessary to facilitate the lowering and fixing of sluice valve shall not be paid for.

16.1.5 Testing:

After installation of sluice valve the same is tested to 1 ½ times of its test pressure. The joints of sluice valve shall withstand the test pressure of pipeline.

Defects noticed during test and operation of sluice valve shall be rectified by the Contractor at his own cost, without any extra claim, to the entire satisfaction of the Engineer in charge.

16.1.6 Mode of Measurement and Payment:

The measurement shall be taken per number of sluice valves of specified size and payment shall be on number basis for providing and fixing.

16.2 FIXING OF AIR VALVES:

16.2.1 General:

The specification placed down requirement for lowering laying and fixing Air Valves.

16.2.2 Preparation:

The air valves and the isolating valves shall be examined before laying for cracks and other flaws. Only undamaged air valve shall be used. The air valves shall be opened and shaken for the air opening below the vulcanite balls on the bronze seats of the balls before fixing. All grime and foreign materials shall be removed from the inside before placing. The flanged face shall be thoroughly cleaned and coated with a thin layer of

mineral grease. In case of screw down type, the threads shall not be in damaged condition.

16.2.3 Jointing Materials:

The Contractor shall provide all the necessary jointing materials, such as nuts, bolts, rubber packing, white zinc jute, lead wool etc. at his cost. All tools and plant required for installation of air valve shall be provided by the Contractor at his cost. All the jointing materials shall be got approved from Engineer in charge before use. The nuts and bolts shall conform to IS: 1364 and the rubber packing shall conform to IS: 638.

16.2.4 Installation:

The air valves shall be fixed on a branched flange Tee on the main pipeline. The air valve and isolating sluice valve shall be housed in a chamber.

17.2.5 Testing:

The specification pertaining to sluice valve shall also apply to air valves.

16.2.6 Mode of measurement and payment:

The measurement shall be taken per number of air valves of specified size and payment shall be on number basis for providing and fixing.

16.3 Fixing scour valve

Scour valves shall be fixed at places shown in the drawings or as directed by the Engineer, and the scour connections from the main carried out completely as per drawings.

16.4. Masonry Chambers

Chambers for sluice valves, inspection branches scour valves, air valves shall be constructed on the pipes in the positions as shown in the drawings or in such positions as the Engineer may direct. The work shall be done strictly in accordance with the detailed drawings or as ordered by the Engineer. The excavation shall not be made lower than necessary to admit of the earth being properly timbered. The bottom for the excavation shall be properly levelled up rammed and a bed of concrete laid thereon. When the concrete has sufficiently set the building of the brick walls shall then be proceeded with and all iron work

fixed in as the building proceeds. The inside of all chambers shall be plastered with cement mortar 20 mm thick and the outside with cement mortar 12 mm thick. The Chamber shall be topped with pre-cast R.C.C. slab by a layer of cement mortar of the sides of the surface box or valve cover covered over with cement concrete.

Where pipes pass through walls of chambers relieving arches shall be turned neatly over the upper of the pipes or R.C.C. lintels shall be provided to a void load of the walls being transmitted to the pipes.

Cast Iron steps shall be built in each chamber as the work proceeds one being inserted to every 4 courses of brick work, horizontal distance center to center of each row being 30 cms.

The Contractor shall include in his rate for brick work cost for fixing steps, frame, cover etc., for completing all chambers in accordance with the drawings and with the above specifications, unless otherwise indicated.

16.5 FIXING OF C.I. M.H. FRAME AND COVER IN RCC SLAB:

16.5.1 General:

The specification includes all requirements of fixing C.I. M.H. frame and cover of specified size and weight in the RCC slab with locking arrangement. For fixing the C.I. M.H. frame and cover of specified size and weight, the frame shall be fixed generally at the time of casting RCC slab with proper anchoring.

After fixing the M.H. frame and cover locking arrangement shall be provided as per following unless specified in the wording of the item. The size of the M.S. flat shall be 50mm x 10mm with M.S. bar U shape of 16mm dia. The U shape M.S. bars shall be properly embedded in the RCC roof slab and anchored. The C.I. M.H. frame and cover and the locking arrangement after fixing shall be painted with anticorrosive black paint. The work shall be done to the entire satisfaction of the Engineer in charge.

16.5.2 Mode of measurement and payment:

The item shall include:

- a) All labour for fixing M.H. frame and cover
- b) All material and labour of locking arrangement
- c) Painting of the frame, cover and locking arrangement

CHAPTER 17- PUMPS, MACHINERIES AND ELECTRICAL WORKS

General Specifications -Electrical & Machineries.

Following clauses specify General Electrical requirements and standard of workmanship for the equipment and installations. General Specification clauses shall apply where appropriate except where particularly redefined elsewhere.

I. Electrical Wiring and installation of fittings

1. The materials used shall conform to the relevant I.S.S where applicable. The make and other details of materials to be used should be furnished along with the tender.
2. Continuous earth connection are to be made with 14 SWG T.C. wire.
3. The wiring work done shall be neat, true to line, level etc. and in such a way that it gives an impressive and aesthetic appearance to the building.
4. The actual location and number of points for lights, fan powers plugs etc., may be altered at the time of execution by the Engineer.
5. Entire wiring and cabling work should be done as per IE rules.
6. Any damages or breakages, chipping etc., caused by the electrification works to the structures have to be rectified by the contractor at his cost of the satisfaction of the Engineer.
7. The contractor has to test each and every point after completion of wiring to the entire satisfaction of the Engineer by taking temporary supply from the existing service.
8. Wiring to light point (both internal and external) and fan point will be treated as complete only when supply as well as connection upto the ceiling rose is completed.
9. Whenever conduit pipe wiring is done, cover for switch board containing switches plugs, etc., should be a hylam sheet or other specified sheet only.

II. Machinery and other Equipments

1. All the materials used shall conform to relevant I.S.S. wherever applicable and should be delivered at site of work. The contractor is responsible for safe custody of materials and equipments under this contract till handing over to the Board.
2. The rates should include all the minor items of civil works if any required for installation complete.
3. All necessary civil works for erection of all equipments for accessories offered by the Contractor under this contract should be done by the Contractor. The rates for civil works are to be quoted wherever called for.
4. Test certified for machinery and equipments should be produced along with the supply.
5. The contractor should supply one set of tools for the pumpset maintenance of the machinery and equipments supplied by them under this contract.
6. The contractor has to operate and maintain the pumpsets and other machinery and equipments for a period of 30 days to the entire satisfaction of the Engineer, free of cost, unless otherwise specified. Fuel, lubricants and power supply if required will be supplied free of cost, for operation and maintenance during that period.
7. The tender should enclose along with their tender performance curves including efficiency curves of the pumpsets, makes and other details and certificates from their claimed manufacturers, stating that the equipments offered by them would be supplied by the manufacturers.
8. The contractor should supply immediately after commissioning three sets of operation and maintenance manuals for all equipments and machinery supplied under this contract.

General

1. Cable lengths given are only approximate and payment will be made for the actual length of cable laid.
2. The contractor has to make necessary arrangements to get supply of electricity from TNEB for operating the machinery and equipments. The necessary Service Connection and S.D. charges will be paid by the Board.
3. The contractor should obtain all approvals for the installation and commissioning of machineries and accessories offered by them from the respective inspecting

authorities such as CEIG or CFIG etc., Fees if any, to be paid to the inspecting authorities will be reimbursed by the Board.

4. Before supply of the machinery equipments and other materials, prior approval of the Engineer should be obtained giving the name of maker and other details required.

GENERAL SPECIFICATIONS - ELECTRICAL

1. Equivalency of Standards and Codes

Wherever reference is made in the contract to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the contract. Where such standards and codes are national or relate to a particular country or region, other authoritative standards which ensure a substantially equal or higher performance than the standards and codes specified will be accepted subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the documents.

2. Use of Trade Names

Wherever reference is made in the Contract to specific manufacture's or trade names the Contractor shall be entitled to substitute plant and materials supplied by other manufacture's or produce's. Such substitutions shall be to the approval of Engineer, which will not be unreasonable withheld. At the request of the Engineer the Contractor shall provide full evidence to establish that the substituted plant and material is equal to or better than that from the manufactures or supplied mentioned in the Contract.

3. Requirement of Statutory Authorities

The electrical equipment / installations shall comply with the requirements of Rules / Regulations as amended up-to-date, required by Statutory Acts or Authorities.

- The Indian Electricity Rules, 1956
- The Indian Electricity Act.
- The Indian Electricity (Supply) Act, 1948
- The requirements of Chief Electrical Inspector to the Government of Tamil Nadu.
- The requirement of Tamil Nadu State Electricity Board.
- Fire advisory Committee Insurance Act.

- The contractor shall get the drawings, layouts of HT sub station etc. approved from TNEB and Chief Electrical Inspector to the Govt. of Tamilnadu, wherever necessary. The contractor also shall arrange to get the installation inspected by CEIG and carryout modifications/rectification as required by CEIG, prior to commissioning of sub station/electrical equipments.

4. Voltage Regulation

During starting of heavy equipment the voltage may drop by a maximum of 15% for period of 45-60 seconds depending upon the duty of the driving equipment. All the electrical equipment shall, therefore, be suitable for trouble free and uninterrupted operation even during such voltage variation at the time of starting of heavy equipments.

5. Ambient Temperature

Where the equipment is installed outside and exposed to direct sunrays, these shall be suitable for operation at higher ambient temperature and rigorous weather conditions under which they are required to operate.

6. Power Factor

Suitable rating capacitors shall be provided to each individual motor above 1.5 KW rating along with discharge device of appropriate rating to improve the power factor above 0.95.

7. Approval by Fire Insurance Authority

The equipment supplied along with the accessories shall be those approved for use in Electrical installations by the Fire Sectional Committee, Central Regional Council of the Insurance Association of India.

8. Conditions of Operation

The equipment offered shall be suitable for continuous operation under high ambient temperature 45°C. Motors for outdoor installation shall be weather proof.

The switch board shall not be exposed to moisture or corrosive gases.

The Contractor shall submit layout drawings showing the location of switch board and other equipment proposed to be installed for the approval of Engineer.

9. LT Supply

The contractor shall ascertain the availability of LT supply from TNEB and to procure equipments accordingly.

9.1 MV / LT Panel

The medium voltage control panel or motor control panel shall normally have ACBs, MCCB and MCB as the case may be. The number of equipments and capacity of each equipment shall depend on the requirement of a particular pumping station. The Panel shall be made of 12 SWG (2.6mm) sheet steel for the front side and 14 SWG (2.0mm) sheet steel for bottom and other sides with powder coating for long life. Necessary neutral link block to be provided at required locations. These panels shall be front wired, front connected and provided with closing handles with ON and STOP mechanical indication having in built locking system so that back access would not be required for inspection and maintenance. The enclosure shall be dust and vermin proof type. Since the entry of cables of the panel is generally from the bottom, the cable gland supporting plate shall be mounted not less than 300 mm above the floor level.

9.2 Air Circuit Breakers

The medium voltage cubicle type switch boards shall consist of four pole Air Circuit Breakers conforming to latest revision of IS:13947 Part 2 / IEC:60947 Part 2. The breaker shall be manually draw out type in open execution with over current trip device adjustable 64% to 110%. Time setting for over load, adjustable current setting for short circuit protection and also earth fault protection adjustment facility shall be provided in the ACB.

ACB shall be fitted with following :

- Heavy duty switch having not less than 4 No. + 4NC contacts
- Built in resin cast current transformer
- Auxiliary contacts
- Shunt and under voltage tripping device
- Neutral CT for earth fault protection
- The ACB shall be suitable for locking the breaker in various position. Provision for door locking ACB shall be provided with the requisite end termination lugs/sockets. Terminal bars for connecting more than one terminal.

The ACB shall have breaking capacity not less than 35kA at 415V AC.

9.3 Moulded case circuit breakers

Moulded Case Circuit Breakers conforming to latest revision of IS:13947 Part 2 / IEC:60947 Part 2 shall be fixed type fitted with trip free, manually closing mechanism, accommodated in a sheet steel housing of robust and vermin proof construction matching with switch boards. All MCCBs shall be tested as per IS-2516 Part-1, Sec-1 and shall be provided short circuit and overload protection. (position of the knob shall clearly indicate ON, OFF and TRIP conditions).

9.4 Terminal Blocks

Terminal blocks shall be 650 V grade, 10 Amps., rated one piece moulded, complete with insulated barriers, screw type brass terminals suitable for stacking on C type rail and identification strips. Marking on the terminal strips shall correspond to wire numbers on the wiring diagrams. The terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. Also CT secondary leads shall be provided with short circuiting and earthing facilities.

All spare contacts and terminal of panel mounted equipment and devices shall be wired to terminal blocks.

At least 20% spare terminal shall be provided on each panel, uniformly distributed on all terminal blocks.

9.5 Indicating Instruments

All electrical indicating instruments shall be digital square type of 144 sq.mm or 96 sq.mm according to the suitability of panel. These shall be suitable for flush mounting with only flanges projecting on vertical panel. Instrument dial shall be white with black numerals and lettering.

Instrument shall conform to IS - 1248 and shall have accuracy class of 1.00 or better. The current coil of ammeters and potential coils of voltmeters shall continuously withstand 120% of rated current and voltage, respectively, without the loss of accuracy.

The meters shall have external zero adjustments. The ammeters fitted in the motor circuits shall have suppressed scale to indicate the maximum starting current. The instrument shall be provided with glass cover to avoid the possibility of measurements due to static charge.

The three phase three wire trivector meter shall comprise of kWh meter and kVARh meter mounted together with kVAh meter in one case with special summator mounted between them to register correct kVAh at all power factors.

All the meters shall have respective maximum demand indicators to record the average power over a period of half an hour. The trivector meter shall conform to relevant IS.

9.6 Equipment wiring

All the switch boards, panels, annunciator panel and mimic panel shall be neatly wired using 1100/660 volt grade PVC insulated stranded copper conductor cable of minimum 2.5 mm to suit the requirement. The wiring shall be bunched in groups by non-metallic clips or bands. Each group shall be adequately supported along its run to prevent sagging and strain on the terminals.

Sharp and tight bends shall be avoided. Each wire shall be identified at both ends by ferrules indicating the designation of the wire in accordance with the Schematic / wiring diagrams. The wire shall be terminated on the terminals of the relays, switches, instrument, conductors, lamps etc., or on the terminal blocks as the case may be. No joints shall be provided in between. Terminal blocks shall have screw type terminals which can take at least two wires per terminal on each side. At least 20% spare terminals shall be provided on each terminal block.

9.7 Interlocking Arrangement

The panels containing the MCCB / MCB etc. shall be enclosed in free standing steel sheet enclosure with front cover so interlocked with the isolator that the door cannot be opened with isolator at 'ON' position.

9.8 Inspection of Circuits

Facility for inspection of the circuits, to ascertain if all the Conductors, relays, fuses, etc. are in proper working order/condition or otherwise shall be provided by means of a push button or selected switch.

9.9 Labeling

Labels of switch gears shall indicate reference number of the switch, the specified current rating and the part of the distribution controlled. Labels on circuit breaker boards shall indicate the reference number of controlling switch. The lettering of all labels shall not be less than 5 mm, high. The schedule and details of the labels shall be submitted to the Engineer for approval.

9.10 Cable Entry

The cable entry shall preferably be from the bottom which shall be dust and vermin proof. The cable entry on each equipment shall be through a compression type cable gland. The cable gland plate shall be sufficiently strong to take the load of the cables and shall be mounted not less than 300 mm. above the floor level. The cables shall be suitably clamped before the cable gland to avoid any strain on it.

9.11 Painting

The panels shall undergo chemical derusting, sand blasting, degreasing, pickling in acid bath and phosphatised as per IS:6005 and primed. The panels shall be thoroughly rinsed with clean water after phosphating, followed by final rinsing with dilute bichromate solution and oven drying. The phosphate coating shall be sealed by the application of two coats of ready mixed, stoving type zinc chromate primer.

Two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The final finished thickness of the paint film on steel shall not be less than

100 microns and shall not be more than 150 microns. The colour for the finishing paint shall be bright battleship grey as per IS:5 (Shade No. 631). The finished painted appearance of panels shall present an aesthetically pleasing appearance free from dust and uneven surface.

The paint shall withstand humid tropical climate, rain, etc. The paint shall not scale or crinkle or removed by abrasion during normal handling.

Sufficient quantity for touch-up paint shall be furnished for application at site.

10. Motor Control Panel

The motor control panel shall have the following equipments.

- Main switch fuse or MCB, MCCB with required capacity in case of 415V motor pumps sets.
- ACB or suitable circuit breaker to suit the motor capacity and voltage in case of HT motor pump sets.
- Motor starter - Auto transformer / Star Delta.
- Contactors
- Single phase preventor
- Ammeter with selector switch
- Voltmeter
- Pilot lamps for indication
- Trip Alarm
- Stop push button
- Start Push Button
- Addition equipments if any

10.1 Push Button Operated DOL Starter

DOL starters shall be of double break type and shall incorporate air break contactor with bimetallic thermal electro magnetic overload relays on all three phases with start/stop push button in front of switch board. The starter shall be capable of 10 operations per hour. The DOL starter shall conform to IS-13947 – Part 4 – Sec 1 (IEC 947-4-1 -1990).

10.2 Star / Delta Starter

The push button operated Star Delta Starter shall be of the fully automatic type with an adjustable timer incorporated for automatic change-over from Star to Delta. The starter shall incorporate the electro magnetic or thermal type bimetallic overload releases, pneumatic electro time delay relay, the solenoid coil operated under voltage release and

current operating single phasing preventor. The starter shall be capable of 10 operations per hour. The starter shall conform to IS-13947 – Part 4 – Sec 1 (IEC 947-4-1 -1990).

10.3 Auto Transformer Starters

The auto transformer starter shall be of the fully automatic type. For auto transformer starting, magnetically operated starting, accelerating and running contactors shall be provided either, operating under solid state or electronic timing devices. The auto transformer shall limit the starting current to 1.5 times full load current for motors upto 100 HP and 1.25 times full load current for motor above 100HP with appropriate tapping. The auto transformer shall be provided with one under voltage coil, three magnetically operated overload coils, and a single phasing preventor relay. One ammeter of ample capacity to take care of the starting current shall also be provided in the starter. The starter in general conform to IS-13947 – Part 4 – Sec 1 (IEC 947 -4-1 - 1990).

10.4 Soft Starters

The Low Voltage Soft Starter shall generally conform to IS 13947. The starter shall employ semiconductor components (IS 12974 latest publication) or reactors (IS 555 Part 3) for limiting the starting current. The starter shall be suitable to operate at 415volts +/-10%, 3 phase / 50 hz +/-3% power supply. The Soft Starter shall be rated equivalent to the motor rated power and shall be capable of operating satisfactorily with the motor under the various loading and starting conditions of the motor over the entire operating range. The Soft Starter shall reduce the starting current of the motor within the level prescribed by the electricity supply authority. The Soft Starter shall be so rated as to allow six starts per hour.

The soft starter shall work on the principle of full sine wave control and shall not lead to generation of harmonics.

The three phase windings of the Soft Starter in case of series reactor type, shall be with insulation class H and maximum temperature of winding shall be limited to that of class B. The reactor shall be such that the losses due to the reactor shall be least.

The Soft Starter shall be housed in a sheet steel enclosure of thickness not less than 14 gauge and painted with corrosion resistive paint such as epoxy or Polyurethane. The degree of protection shall be I.P.41. Soft Starter shall have a built in facility for bypassing the current limiting component after the motor reached the full speed so that the incoming voltage to the motor is equal to the supply voltage.

Routine test :-

Manufacturer should have following mandatory test facilities for routine tests at his shop.

1. High voltage test.

2. Full current injection test – A.C.Current equal to designed motor starting current should be injected in to starter for time equal to starting time.
- Insulation resistance test.

10.5 Timer

Knob type electro-pneumatic time delay relay range 0-60 sec. It shall conform to IEC.337-1-1970 or IS-5834 Part I, convertible from ON delay to OFF delay or vice versa, suitable for 110 V AC 50 Hz rating, 1.5 Amps, terminal capacity for 2.5 mm² copper control wire, with 1 No + 1 NC.

10.6 Isolating Switches

Isolating switches shall be on load double break type and shall have suitable current and voltage ratings. The “ON” and “OFF” position shall be clearly marked.

Isolators used for motor control circuits shall be of motor cut type, capable of carrying the starting current of the motor.

10.7 Fuses and Fuse Carrier

All fuses shall be HRC cartridge type conforming to IS:13703, mounted on plug-in type fuse bases. All accessible line connections to fuse base shall be adequately shrouded. The fuses shall have operation indicators for indicating blown fuse condition. The fuse and fuse carrier shall be suitably selected for rated and fault currents. The fuse for motor control circuits shall be so selected that the same shall not operate during motor starting.

10.8 Contactors

The three pole contactors with minimum of 2 No. + 2 NC working contacts and one number of 1 No + 1 NC spare contact shall be used. The contact made of anti-weld silver cadmium shall be designed to give minimum bounce to ensure long contact life. The rating of the contactor shall suit the motor and capacitor circuit duty. The contactor shall be suitable for 415V, 50Hz, AC 3P hase duty in respect of making and breaking operations at specified power factors. The contactors shall conform to IS:13947 Part-1 and Part-4.

10.9 Single Phase Preventor

The single phasing preventor shall be provided for all 415 V, motors above 5 kW rating. The single phasing preventor shall be current operated type using minimum current detection / negative phase principle. Necessary current transformers shall be provided to suit the requirement of the single phasing preventor. The single phasing preventor shall be stable during the starting of the motor. The maximum operating time to the single phasing preventor shall not exceed 2/3 second even in the starting condition of motor.

11. Cables and Cable Laying

Following type of cables shall be used.

1. For LT Power Supply : 3½ core, 3 core or 2 core 1100 / 600 V PVC insulated PVC sheathed armoured cables.
2. For control cables : Multicore copper cable minimum 2.5 mm² with PVC insulation, armoured and PVC sheathed.
3. Submersible Motor cable : According to Manufacturer

The minimum size of control cable shall not be less than 2.5 mm².

All cables shall be suitably de-rated for grouping and higher ambient temperature. For selecting cable sizes, 45⁰C ambient temperature shall be taken as base.

The cables shall conform for LT to IS:1554 - Part I and for HT to IS 1554 - Part - II., IS: 7098.

11.1 Cable Accessories

All accessories like cable glands, lugs and terminal markings etc. shall be used conforming to relevant standards / as specified. For 1100V grade cables Siemens type gland and crimping type lugs shall be used.

11.2 Cable Laying

The power cables and its accessories shall conform to latest relevant Indian Standards. While laying the cables care shall be taken to avoid formation of kinks and damages to the cables.

LT cable shall be laid on wall with suitable clapping or trays or buried underground with appropriate protection. Black shall indicate the neutral, while red, yellow and blue for three different phases. All LT cables when laid on the cable racks shall be properly dressed and clamped as required without crisscrossing and unnecessary overlapping. Cables shall be properly dressed and clamped.

11.3 Laying of LT under ground cables.

The laying of UG cables on ground is by excavating a trench of 0.75 meter depth for LT cable. Before the cable is laid in the trench, the bottom of the trench shall be cleared from stones and other sharp materials and filled with sand layer of 150 mm.

The width of the trench at bottom shall be 0.4 meters for one cable. In case the total number of cables laid in trenches is more than one, then the width shall be such that

the spacing between cables is not less than 150 mm. Each run of cable shall be protected by placing bricks / RCC slabs on both the sides and top.

After placing bricks or RCC slabs, the trench shall be filled with the excavated soil, in layers ensuring that at each layer is well rammed by spraying water and consolidated. The extra earth shall be removed from the trench and disposed as directed.

When cables pass through roads they must be well protected by either hume pipes or GI pipes of suitable dimensions properly sealed at either end and also at the joints with suitable compound to avoid entry of soil and water.

While removing the cable from the drum, it shall be ensured that the cable drum is supported on suitable jacks and the drum is rotated to unwind the cable from the drum. The cable should never be pulled while unwinding from drum. It shall be ensured that the cables are run over suitable wooden rollers placed in the trench at intervals not exceeding 2 meters.

In routing, necessary barriers and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angles and these two shall not run in close proximity. LT cables shall be bent in radius not less than 12 times their individual overall diameters.

Routes of these cables shall be arrived at on the basis of the relevant drawings and after consulting the Engineer.

Contractor shall provide all necessary labour, tools, plants and other requisites at his own cost; for carrying out pumping of water and removing of water from trenches if required anywhere at the time of execution.

11.4 H.T. Cables

H.T. 11 KV grade suitable rating 3 core XLPE aluminium conductor cable minimum size 150 mm² from TNEB supply point to Employer's 11 KV primary control switch gear and to transformers as per requirement.

11.5 Specifications for H.T. Cables

This specification covers the requirements of high voltage cables and associated accessories like straight joints and terminations etc. The cable sizes shall be calculated based on the fault level of the local system. Minimum size of HT cables shall be 150 mm² in case of XLPE cables.

11.6 Codes and Standards

1. The design manufacture and performance of the cables shall comply with all currently applicable statutes regulations, and safety codes in the locality where they will be

installed. Nothing in this specification shall be construed to relieve the Contractor of his responsibility in this regard.

2. The cables shall conform to the latest editions of following IS and other relevant IS mentioned therein

IS 7098 (Part-II): Specifications for cross linked polyethylene Insulated PVC sheathed cables for working voltages from 3.3 KV up to and including 33 KV.

11.7 Drawings and Schedules

Sizes of cables shall be given in single line power diagrams. A cable schedule shall be prepared on the basis of relevant drawings. All cable and wires shall be adequately sized to carry continuously the normal currents expected on the relative circuits. All trenches for electrical cables shall be separate from water or sewage pipeline trenches.

11.8 Splicing and Termination

Straight through joints shall be avoided. In case, these are absolutely necessary they shall be made at convenient locations suitably protected as approved and sanctioned by the Engineer-in-charge but in no case within the conduit pipes or ducts. Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes, light fixtures outlets and circular junction boxes. They shall be made only with approved porcelain connectors.

Cable glands for strip armored cables shall include suitable armour clamps for receiving and securely attaching the armoring of the cable in a manner such that no movement of the armour occurs when the assembly is subjected to tension forces. The cable gland shall not impose on armoring, a bending radius not less than 15 times the diameter of the cable. The clamping ring shall be solid and adequate strength.

Provision shall be made for attachment of an external earthing bond between the clamp of the cable and the metallic structure of the apparatus to which the cable box is attached.

Compression type cable end glands shall be used for cable connections. Double compression cable end glands shall be used for flame proof switch gears. Cable glands shall be of brass with cadmium or nickel plating.

Tinned copper lugs shall be used for cable termination.

Cables shall be tested in accordance with IS:1554 / 7098

11.9 Testing of Cables

Once the cable is laid, following tests shall be conducted in presence of the departmental representatives authorized by Engineer, before energizing the cable.

1. Insulation resistance test (Sectional and Overall).
2. Sheathing continuity test.
3. Continuity and conductor resistance test.
4. Earth test.
5. High voltage test.

Test conducted shall be as per Indian standard and National Electrical code.

12. Control Switches

Control and instrument switches shall be of rotary type flush mounting having enclosed contacts which are accessible by the removal of cover and shall be provided with properly designated escutcheon plates clearly marked to show the operating positions. Control switches shall have momentary contacts, spring return to centre with pistol grip handle. Instrument and selector switches shall have oval knob.

13. Push Buttons

Push Buttons shall be of momentary contact type with rear terminal connections. The colour of the push buttons shall be “Green” for start and “Red” for stop. Whether required, the push button shall be suitably shrouded to prevent inadvertent operations. They shall be provided with integral inscription plates engraved with their functions. The contact element shall have at least 1 No. and 1 NC contacts. The contacts shall be able to make and carry at least 6 Amp. at 415 AC.

14. Indicating Lamps

Indicating lamps shall be panel mounting type with rear connection. The lamps shall be provided with the built-in series resistors on the lamp holder. The lamp shall have translucent lamp cover, of suitable colour. The cover shall be oil and dust proof poly-carbonate lense. The bulb and lenses shall be interchangeable and replaceable from front of the panel.

15. Safety Equipments to be Provided

The contractor shall provide the following safety equipments as per IE rules,

- Rubber mat conforming to relevant IS, in front of all the MV panel for their entire length - 1000m wide
- Sufficient pairs of electrically tested rubber gloves. These are to be kept in a suitable wooden box.
- A shock treatment instruction chart in Tamil and English duly framed as detailed in. The nearest medical facility available with phone number shall

- also be kept
- First aid box containing full complements of medicines for treatment of electrical burns in the main switch room
- Adequate number of portable fire extinguishers of dry powder (store type) as per IS 2171 to suit the individual substation, pumping station requirement.
- Adequate number of caution notices in Tamil and English shall be fixed permanently on the equipment to comply the requirement of IE rules
- Safety posters for vigilance against electrical accidents.
- Adequate number of fire buckets with MS angles stand
- Round bottom fire buckets marked fire shall be provided in the HT sub stations.

16. Lighting & Small Power (IS: 1913, IS: 1777, IS: 1032 Part 5, IS: 13383 Part 2)

16.1 Definitions and Conventional Symbols

The definition of terms shall be in accordance with the Indian Standard Code of Practice for Electrical working installation except for the definition of a “Point”. The wiring and the equipments shall comply in all respects with the requirement of rule 50 and 51 of IE rules / 56 as amended from time to time. The wiring and other electrical equipments shall be suitable for trouble free operation at variation of voltage and frequency prescribed in IE rules.

16.2 Pressure Frequency

Pressure and frequency of supply all current consuming devices shall be suitable for the pressure and frequency of the supply to which these are to be connected and shall function at variation voltage and frequency as per IE rules.

16.3 Point Wiring

Point wiring shall include all work necessary to complete wiring from switch circuit of any length from the tapping point on the distribution circuit switch board to the following.

- Ceiling rose for fans, Lighting etc.
- Socket outlet (in the case of socket outlet points).
- Lamp holder (in the case of wall brackets, batten points, bulk head and similar fittings).
- Call bell buzzer (in the case of the works “via the ceiling rose / socket outlet or bell push where no ceiling rose / socket outlet is provided”).

16.4 Circuit Wiring

Circuit wiring shall mean the length of wiring from the distribution board upto the tapping point of the nearest first points of that circuit, viz., upto the nearest first switch board measured along the run of wiring. Such wiring shall be measured on linear basis.

16.5 System of Wiring

The wiring shall be carried out on such a system as may be specified in the tender schedule or otherwise specified in the special specification ("Power" and "Heating" wiring shall be kept separate and distinct from "Lighting" and "Fan" wiring). Recessed conduit wiring shall be done on distribution system main and branch distribution boards at convenient physical and electrical centers and without fuses at isolated places. All conductors shall run, as far as possible, along the walls and ceiling so as to be easily accessible and capable of being thoroughly inspected. In no case, the open wiring shall be run above the false ceiling without the approval of Engineer-in-Charge. In all type of wiring due consideration shall be given for neatness, good appearance and safety.

16.6 Balancing of Circuits

The balancing of circuits in three phase installations shall be arranged before hand to the satisfaction of Engineer.

16.7 Drawings

All wiring diagrams shall indicate clearly in plan, the main switch board, the distribution fuse board, the run of various mains and sub-mains and the position of all points with their classification

16.8 Cables

All cables shall conform to the relevant Indian Standard. Conductors of all cables except the flexible cable shall be of aluminum.

The smallest aluminum conductors for the final circuit shall have a nominal cross-sectional area of not less than 2.5 sq.mm. The minimum size of aluminium conductors for power wiring shall be 4 sq.mm. (1/2.24 mm).

16.9 Rating of Lamp, Fans, Socket Outlet Points and Exhaust Fans

Incandescent lamps installed in pump house & other means shall be rated at 60 watts and 100 watts respectively.

Table fans and ceiling fans shall be rated at 60 watts. Exhaust fans shall be rated according to their capacity.

5 Amps. socket outlet points and 15 amp. socket outlet points shall be rated at 100 watts and 1000 watts respectively, unless the actual values of load are known or specified.

16.10 Joint and Looping Back

Unless otherwise specified the wiring shall be done in the “Looping System”. Phase of live conductors shall be looped at the switch box and neutral conductor can be looped from the light, fan or socket outlet. In non-residential buildings, neutral conductor and earth conductor and earth continuity wire shall be brought to each switch board situated in room and halls. These shall be terminated inside the switch boards with suitable connectors and the switch board shall be of adequate size to accommodate one number 5 amp. socket outlet and control switch in future.

16.11 Control at point of Entry Supply

There shall be a linked main switch gear with fuse on each live conductor of the supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of a linked switch gear. The neutral shall also be distinctively marked. In this connection rule 33(2) of the Indian electricity Rules, 1956 shall also be referred.

16.12 Installation of Main Switch Gear

The main switch gear shall be installed as near as practicable to the termination of service line and shall be easily accessible without the use of any external aid.

16.13 Indication Identifying Earthed Neutral Conductors

On the main switch gear, where the conductors include an earthed conductor of a two wire system or a conductor which is to be connected thereto, an indication of a permanent nature conductor. In this connection Rules 32(1) of the Indian Electricity Rules, 1956, shall be referred.

16.14 Marking of Apparatus

When a board is connected to voltage higher than 250 volts all the terminals or loads on the apparatus mounted on it shall be marked in the following colours to indicate the different poles of phases to which the apparatus or its different terminals may have been connected.

AC Three Phase	:	Red, Blue and Yellow
Neutral	:	Black

When four wire three phase wiring is done, the neutral shall preferably be in one colour and the other wires in another colour.

Where a board has more than one switch gear each such switch gear shall be marked to indicate which section of the installation it controls. The main switch gear shall be marked as such. Where there is more than one main switch board in the building, each switch board shall be marked to indicate which section of the installation and building it controls.

All markings required under this rule shall be clear and permanent.

All distribution boards shall be marked 'Lighting' or 'Power' as the case may be and also marked with the pressure and number of phases of the supply. Each shall be provided with a circuit diagram and the current rating of the circuit and size of the fuse element.

16.15 Main and Branch Distribution Boards and their Locations

Unless otherwise specified in the special specification main and distribution fuse boards shall be the metal clad type.

Main distribution Boards shall be controlled by a linked fuse unit and a circuit breaker. Each outgoing circuit shall be provided, of MCB with S P / TP as per requirement

Branch Distribution boards shall be controlled by a MCB. Each outgoing circuit shall be provided with a fuse or MCB. The earthed neutral conductors shall have provision for disconnecting individually for testing purpose. At least one spare circuit breaker of the same capacity shall be provided on each branch distribution board.

16.16 Capacity of Circuits

Lights and fans may be wired on a common circuits, such circuit shall not have more than a total of ten points of light, fan and socket outlet or a load or 800 watts whichever is less.

Power circuits on buildings shall be designed with a maximum of two outlets per circuit, based on the loading.

Where, not specified the load shall be taken as 1 kW per outlet. Wherever the load to be fed is more than 1 kW it shall be controlled by an isolator switch or miniature circuit breaker.

16.17 Passing Through Walls

When conductors pass through walls, any one of the following methods shall be employed. Care shall be taken to see that wires pass very freely through protective pipe

or box and that wire pass through in a straight line without any twist or cross in wires, on either ends of such holes.

A conductor shall be carried in an approved heavy gauge solid drawn or lap welded conduit or in a porcelain tube of such a size that it permits easy drawings in. The ends of conduit shall be neatly bushed with porcelain, wood or other approved material.

Where a wall tube passes outside a building so as to be exposed to weather, the outer end shall be well mounted and turned downwards and properly bushed on the open end.

16.18 Fixing to Walls and Ceiling

Plug for ordinary walls or ceiling shall be of well seasoned teak or other approved hard wood not less than 5 cm. long by 25 cm. sq. on the inner and 2 cm. sq. on the outer end. They shall be cemented into walls within 6.5 mm of the surface the remainder being finished according to the nature of the surface with plaster. Where owing to irregular coarsing or other reasons the plugging of the walls or ceiling with wood plugs present difficulties, the wood casing, wood batten or metal conduit shall be attached to the wall or ceiling in an approved manner. In the case of white washing. Plugging of walls or ceiling can be done in a better way where neatness is the first consideration. In all such case approved type of asbestos or fiber fixing plug (Rawl or Phil plug) with correct size of tees shall be used and done in a workman like manner.

Where this cannot be done, wooden plugs as described can be used with special permission of the Engineer.

16.19 Fittings

Lights, fans and sockets outlets shall be so located as to provide maximum comfort to the occupant and to enable him to utilise the electricity in the most economical manner.

Where conductors are required to be drawn through tube or channel leading to the fitting, the tube or channel must be free from sharp angles or projecting edges.

Non-flammable shade form a part of a light fitting against all risks of fire, celluloid shade or light fittings shall not be used under any circumstances. Vitreous enameled iron shade shall be of size 250 mm x 90 mm (nominal) size with a tolerance to 5 mm). Plastic shade shall not be generally used in the fittings suitable for incandescent lamp.

Enclosed type fittings shall be provided with a removable glass receptacles, arranged to enclose the lamp completely and of such size of construction as to prevent undue heating of the lamp, or if the position of fittings be such that the glass shall be

protected by a suitable wire guard. The loads of pre-wired fixture shall be terminated on ceiling rose of connector.

External light fittings and lamps shall have weather proof fittings of approved design so as to effectively prevent the admission of moisture. An insulating distance piece of moisture proof material shall be inserted between the lamp holder nipple and the fittings.

In verandahs and similar exposed situations, where pendants are used they shall be of fixed rod type. Bulk head type fittings shall be of cast iron/cast aluminum body suitably painted white inside and gray outside complete with heat resistance glass cover, P.C. holder and wire guard suitable for 100 watts incandescent lamp. Where specified gasket for cover and shock proof B.C. holder shall be provided. Fluorescent tube light fittings of 40W / 80W fixed type shall be provided in general for conservation of energy and less maintenance.

16.20 Accessories

All switches shall be placed in the live conductor of the circuit and no single pole switch or fuse shall be inserted in the earth or earthed neutral conductors of the circuit.

16.21 Socket Outlets

A socket outlet shall not embody terminal as integral part of it. But the fuse may be embodied in plug in which case plug shall be non-reversible and shall be so arranged and connected that the fuse is connected to phase, live conductor or the non-earthed conductor of the circuit.

Every socket outlet shall be controlled by a switch.

The switch controlling the socket outlet shall be on the 'Live' side of the line.

5 Amps. and 15 Amps socket outlets shall normally be fixed at any convenient space 23 cms above the floor level or near such levels in special cases as desired by the Engineer-in-charge. 15 Amps switch and socket should be an integral provision of an indicator diode. The switch for 5 Amps socket outlet shall be kept along with socket outlet. However, in special case, if desired by the Engineer the 5 Amps. socket outlet shall be kept at normal switch level and that for 15 Amp along with the socket outlet. However, in special case, if desired by the Engineer the 5 Amp socket outlet shall be placed at the normal switch level.

Where socket outlets are placed at lower levels, they shall be enclosed in a suitable metallic box, as the case may be to harmonise with the system or wiring adopted. In an earthed system of supply a socket outlet and plug shall be of the three pin type. The third terminal shall be connected to earth.

Conductors connecting electrical appliance with a socket outlet shall be of flexible twin cord with an earthing core which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.

16.22 Attachment of Fittings and Accessories

In case of conduit wiring, all accessories like switches, sockets, outlets, call bell pushes and regulators shall be fixed in flush pattern inside metal boxes. Accessories like ceiling roses, brackets, battens, stiff pendants, etc. shall be fixed on metal outlet boxes. Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases. The blocks/board shall normally be mounted with their bottom 1.25 m from floor level. The Boards shall have a sunmica finish.

16.23 Surface Conduit Wiring System

Conduit pipes of approved gauge thickness shall be used. The maximum number of VIR/PVC insulated 250 volts grade aluminum conductor cable that can be drawn in one conduit of various sizes and the number of cables per conduit shall not be exceeded. The minimum conduit disconnector shall not be less than 25 mm.

In long distance straight run of conduit, inspection type junction box at reasonable intervals shall be provided.

16.24 Fixing of Conduit

Conduit pipes shall be fixed by heavy gauge clamps, secured to suitable wood plugs or other approved plugs with screws in an approved manner at an interval of not more than one metre but on either side of the couplers, bends, or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings. The saddle should not be less than 24 gauge for conduits upto 25 mm dia and not less than 20 gauge for larger diameter.

Where conduit pipes are to be laid along the trusses, steel joints etc. the same shall be secured by means of ordinary clips or girder lips as required by the Engineer-in-charge. Where it is not possible to drill holes in the truss members, suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girder clips and clamps shall not be less than as stated below:

16.25 Switch Box

Switch box shall be made of metal on all sides, except on the front.

In the case of cast boxes, wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes the wall thickness shall not be less than 18 gauge for boxes, upto a size of 20 cm x 30 cm and above this M.S. boxes shall be used. Except where otherwise stated 3 mm thick phenolic laminated sheets like sunmica shall be fixed

on the front with brass screws. Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern. All fittings shall be flush pattern. Only a portion of the above box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

16.26 Conduit Wiring System

Conduit wiring system shall comply with all the requirements of surface conduit wiring system specified in clauses above and in addition to the requirements specified in the following clauses.

The chase in the wall shall be neatly made and ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under construction, fixed work, special care shall be taken to fix the conduit and accessories in position along within the building work, to avoid damage to the finished wall etc.

All outlets such as switches, wall sockets etc. shall be flush type.

The outlet box shall be same as above and shall be mounted flush with the wall. The metal box shall be efficiently earthed with conduit by an approved means of earth attachment.

To facilitate drawings of wire in the conduit. G.I mesh wire of 10 SWG shall be provided while laying of recessed conduit.

16.27 Fans, Regulators and Clamps (IS: 374)

Ceiling fans including their suspension shall conform to relevant Indian Standards.

All ceiling fans shall be wired to ceiling roses or to a special connector boxes and suspended from hooks or shackles with insulators between hooks and suspension rods. There shall be no joint in the suspension rod

For concrete roofs, ceiling fan hooks shall be buried in the concrete during construction. M.S. flat of size 40 mm x 6.0 mm bent in the form of an inverted 'U' supported on two cross rods or cross flats. 60 mm long which are bound together to the top reinforcement of the roof shall be used. The distance between the vertical legs shall not be less than 15 cm. and the legs shall project at least 13 cm below the ceiling and oval holes shall be made in them for carrying a 15 mm dia rod hook.

Alternatively a 15 mm dia, M.S. rod in the shape of 'U' with its vertical legs bent horizontally at the top at least 19 cm. on either side and bound to the top reinforcement of the roof shall be used.

In building with concrete roofs having a low ceiling height where the fan clamp mentioned under clause (c) can not be used or whatever specified, recessed type fan clamp inside a cast iron box shall be used.

Canopies on top of suspension rod shall effectively hide the suspension.

Unless otherwise specified all ceiling fan shall be hung 2.75 M above the floor.

In the case of measurement of extra down rod for ceiling fan including writing the same shall be measured in units of 10 cms. Any lengths less than 5 cm. shall be ignored.

16.28 Exhaust Fans

Exhaust fans shall conform to the relevant Indian Standards.

Exhaust fans shall be fixed at the places indicated by the Engineer-in-charge. For fixing an exhaust fan, a circular hole shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded to the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to exhaust fan point which shall be wired as near to the hole as possible by means of a flexible cord, care being taken that the blades rotate in the proper direction.

Exhaust fans for installation in corrosive atmosphere fan shall be painted with a special PVC paint or chlorinated rubber paint (Chloro rubber paint). Installation of exhaust fans at locations need careful consideration. The regulators of ceiling fans/exhaust fans shall be connected to earth by loop earthing.

16.29 Indoor Decorative Luminaires

Luminaire shall be suitable for use with twin/single T.L. 40 watt 1200 mm (4'), 240V fluorescent lamps, comprising of CRCA sheet steel channel stove enameled grey which incorporates all electrical accessories like quick fit lamp holder, starter holder, polyester filled ballast, power factor correction capacitor and duly prewired upto the terminal block, with earthing arrangement facility, cover made for channel from CRCA sheet steel stove white enameled covering the channel fixed by twin screw, suitable for ceiling or pendent mounting suitable for 19 mm dia conduit, reflector plate for acrylic diffuser and end covers, complete in all respects ready for use. The luminaire shall conform to IS:1913.

16.30 Outdoor Lighting

16.30.1 Poles

Street light poles shall be steel tubular swaged type, conforming to IS:2713 - 1969., suitably long with M.S. base plate with pipe cap and over hung 2 metres long having dia

to suit the socket of 70/ 250 watts, 240V, High pressure sodium vapour lamp or metal halide fitting.

16.30.2 Outdoor Luminaire

The luminaire shall be 250 watt H.P.S.V. with all accessories and shall be deep drawn aluminium reflector stove enamelled grey outside and brightened and anodised inside lined with felt gasket to prevent insect entry.

Die cast aluminium housing covered with a lid shall be provided to accommodate all electrical accessories, such as independent ballast, power factor improvement capacitor, wired upto terminal block.

A clear acrylic cover shall be fixed to the reflector by means of 4 toggles.

The luminaire shall be mounted on the mast arm of 50 mm O. D. Mirror compartment and tray compartment shall have degree of protection IP 43 and IP 33 respectively. The reflector shall be manufactured of drawn aluminium sheet and be painted to stove enamel grey outside and brightened and anodised inside.

The housing shall be diecast aluminium - A6 Grade MBV treated covered with acrylic sheet clear.

17. Emergency Light

Emergency light unit working on 230 volts. A.C. supply shall be self containing unit with 20 watts 600 mm long fluorescent lamp type 'SWITCH ON MAIN FAILURE'. It shall be electronic automatic fluorescent type which incorporates a unit trickle charge circuit, which shall prevent overcharging of battery. The battery shall be maintenance free. The unit shall provide 4 hours illumination following power failure. The units shall generally conform to IS:9583.

18. Earthing

Earthing in general shall comply with C.P. (Code of Practice) 3043 of Indian Standards.

Earth electrode either in the form of pipe electrode or plate electrode should be provided at all premises for providing earthing system.

As far as possible, all earth connection shall be visible for inspection and shall be carefully made.

Except for equipment provided with double insulation, all the non-circuit carrying metal parts of electrical installation are to be earthed properly. All metal conduit trunking cases, sheets, switch gears, distribution fuse boards, lighting fittings and all other parts made of metal shall be connected to an effective earth electrode.

The main earth electrode should be G.I perforated pipes driven into the soil as per standard practice. Continuous looped earthing should be provided with adequate size G.I. wire / feat. Earthing work should conform to I.E Rules.

The earth pit shall conform to IS : 3043 and GI earth electrodes of not less than 100 mm external dia shall be driven to a depth of atleast 3m in the ground below the ground level. The surrounding of the electrodes, soil shall be treated up with salt, coke and charcoal.

Earth electrode shall be installed near the main supply point and shall comprise a copper / GI earth of appropriate diameter and driven to depth of 3 metres below ground level, or to a greater depth, if so required to obtain a sufficiently low earth resistance value. Alternatively copper plate may be used as the main earth electrode conforming to IS:3043. The electrodes shall be driven at least 1.5m away from the building or any other earth station.

Minimum requirement of earth pits as per I.E. rules are as under:

The main earth electrodes after being driven into the ground shall be protected at the top by constructing a concrete or masonry chamber of size 300 mm x 300 mm x height 300 mm. and shall be provided with CI cover. The resistance of any point in the earth continuity system of the installation to the main earth electrode shall not exceed 1.0 ohm. The remaining space in the bore hole shall be filled with bentonite. The bentonite will hold the earth rod in position. The neutral conductor shall be insulated throughout and shall not be connected at any point to the consumers earthing system.

An earth continuity conductors shall run continuously from the farthest part of installation to the main earth electrode and shall be connected by branch conductor to all metal casing and heating housing electrical apparatus and/or wires and cables. all branches shall be connected to earthing. The earth continuity conductors shall have a

cross-sectional area at least half to the size of the phase conductor and in no case less than 1.5 sq.mm of copper / GS.

All earth wires and earth continuity conductor shall be galvanised M.S flats of appropriate size. Interconnections of earth continuity main conductors and branch wires shall be brazed properly, ensuring reliable, permanent and good electrical connections. The earth lead run on structures must be securely bolted. Neutral earth leads shall be run on a separate supports without touching the body of the transformers. Earth wires shall be protected against mechanical damage and possibility of corrosion particularly at the junction points of earth electrodes and earth wire interconnections. Earth electrodes shall be connected to the earth conductors using proper clamps and bolt links.

It shall not be allowed to use the armour of the incoming feeders cable to the sub-distribution board as the only earthing system.

Sheathed lugs of ample capacities and size shall be used for all underground conductors for sizes above 3 mm^2 whenever they are to be fitted on equipment or flat copper conductor.

The lugs shall be fitted on equipment body to be grounded or flat copper only after the portion on which it is to be fixed is scrubbed, cleaned of paint or any oily substance on a subsequently tinned.

No strands shall be allowed to be cut in case of stranded ground round conductors. G.I embedded conduits shall be made electrically continuous means of good continuity fixing and also be rounding copper wires and approved copper clamps.

19.1 Earthing of Lighting Poles

All external poles are to be looped together with continuous 14 SWG TC earth wire clamped at dollies provided on every fuse box of poles and looped onwards to the other pole. Every fifth pole shall be connected to earth through an earth electrode.

19.2 Earthing for Lighting Installation

This shall be common grid system, the main grounding conductor laid and embedded in concrete being grounded at earth pits outside the buildings at approved locations or other places. The earthing of L.T panels shall be connected to two main grounding conductors each of which along with main cables shall run with cables to distribution boards in each floor. This shall run along with the cable and at the top floor be connected to the same section completing the grid.

19.3 Sizes of Earthing Conductors

Sl. No.	System	Earthing conductor size and Material
1	415V switchgear, DG set, Capacitor Control panel	Suitable to its rating.
2	415V LT Motors	
	- less than 50 HP	25 X 6 mm GI
	- 50 - 150 HP	40 X 6 mm GI
	- above 150 HP	50 X 6 mm GI
3	Lighting distribution Board,	14 SWG GS wire
4	Local push Button Stations, Junction Boxes.	14 SWG GS wire
5	Lighting and receptacle system	14 SWG GS wire
6	Earth Electrode	50 mm dia. 3000 mm long heavy duty GI pipe electrode
7	Street lighting poles	14 SWG TC wire

Note: 1. Conductors above ground shall be of galvanised steel to prevent atmospheric corrosion.

Note: 2. Conductors buried in ground or embedded in concrete shall be of mild steel.

20 Power capacitor

Power shunt capacitors in general shall conform to latest version of IS: 13585, Part-1. Power capacitor control panel shall be housed in metal enclosed cubicle. Power capacitor shall be mounted on MS angle frame works and capacitor control panel along with MV panel.

The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.

The capacitor bank shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, copper bus bars, copper connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanised.

The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units.

The assembly of the banks shall be such that it provides sufficient ventilation for each unit.

Each capacitor case and the cubicle shall be earthed to a separate earth bus.

Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of the latest edition of IS : 13585 Part 1.

Film dielectric, Aluminium foil conductor, impregnated with Non PCB, Non Toxic biodegradable capacitor grade oil, under vacuum, two layers of biaxially oriented propylene film shall be used.

Each unit shall satisfactorily operate at 135% of rated kVAR including factors of over voltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any over voltage up to a maximum of 10% above the rated voltage, excluding transients.

20.1 Unit Protection

Each capacitor unit shall be individually protected by an MCCB / MCB fuse suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by the fuse without causing the bank to be disconnected. Thus, the fuse shall disconnect only the faulty unit and shall leave the rest of the units undisturbed. An operated fuse shall give visual indication so that it may be detected during periodic inspection. The MCB breaking time shall co-ordinate with the pressure built up within the unit to avoid explosion. Mounting of the individual fuse may be internal or external to the capacitor case.

20.2 Capacitor Control Panel

The control equipment shall be mounted in the MV panel made of 2.6mm / 2.0mm cold rolled sheet steel for the front and other sides respectively. The panel shall be of indoor type and shall consist of :

- Isolating switch / MCB / MCCB
- Red and Green lamps for capacitors ON/OFF indication.

20.3 Technical Particulars - The Equipment shall conform IS 13585 Part 1

- General
 - Quantity : as per requirement
 - Rated capacity as per requirement
 - Rated Voltage : 433 V
 - Rated frequency, and phases : 50 Hz, 3 Phase
 - Design Requirements
- In sulation level : 2.5 KV (rms)

- Capacitor bank connection :Delta
- Short circuit withstand for busbars :
 - Short time (1 sec) : 40 KA (rms)
 - Dynamic : 102 KA (peak)
- Switches
 - Type of switching : MANUAL switching
- Income current rating :To suit-rated capacity of kVAR

20.4 Tests and Test Reports

- All tests shall be conducted in accordance with the latest edition of IS – 13585 Part 1 and as applicable for the controls.
- Type test certificates for similar capacitor units shall be furnished.

20.5 Drawings

The following drawings shall be submitted for the approval of the Engineers Representative.

- Fully dimensioned general arrangement drawings of capacitor and capacitor control panel with elevation side view, sectional view and foundation details.
- Complete schematic and wiring diagrams for capacitor control panel.

21. PUMPING MACHINERIES

21.1 Applicability

The following clauses shall specify general mechanical requirements and standards of workmanship for equipment and installations and must be read in conjunction with the particular requirements of the Contract. These general specification clauses shall apply where appropriate except where redefined in the particular requirement sections of the Specification which shall be applicable

21.2 Materials

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfection, and selected for long life and minimum maintenance.

21.3 Design and Construction

The plant design, workmanship and general finish shall be of sound quality in accordance with good engineering practice. Design shall be robust and rated for continuous service, at the specified duties, under the prevailing operational site conditions.

The general design of mechanical and electrical Plant, particularly that of wearing parts, shall be governed by the need for long periods of service without frequent attention but shall afford ready access for any necessary maintenance.

Similarly items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same material specification as the originals.

No welding, filling or plugging of defective work will be permitted without the written permission of the Engineer. All welding spatter shall be removed.

It shall be the responsibility of the contractor to ensure that all the equipment selected is fully compatible, mechanically, electrically and also with respect to instrumentation, control and automation.

It shall be the responsibility of the contractor to ensure his equipment interfaces with any existing equipment correctly. Any interfaces must not affect the integrity of the equipment, or invalidate any warranties or guarantees.

Each component or assembly shall have been proven in service in a similar application and under conditions no less than those specified therein.

The plant shall be compatible with the civil structure, when installed, with sufficient space for operator access and maintenance procedures.

All materials shall be of the best commercial quality and free from any flaws, defects or imperfections.

Materials shall be selected to eradicate or reduce corrosion to a minimum.

21.4 Tropicalisation

All plant and materials used shall in all respects be suitable for the climatic conditions of the Chennai as detailed in Table - _ hereof. The following maximum conditions shall be used for all design.

- i) Maximum peak ambient shade temperature : 43°C
- ii) Maximum daily average ambient shade temperature : 38°C

- iii) Maximum yearly average ambient shade temperature : 30°C
- iv) Maximum Relative humidity : 100%

In damp situations and wherever exposed to the weather, precautions shall be taken against corrosion of metal work, cable armour, conduit and the like.

All electrical equipment including cables shall be de-rated for continuous operation in an ambient temperature of 45°C in accordance with the appropriate regulations.

All materials and equipment which are subject to certification by testing authorities etc., shall be certified as being tested at 45°C ambient.

Tropical grade materials should be used wherever possible. Some relaxation of these provisions may be permitted where equipment is hermetically sealed.

Iron and steel are in general to be painted or galvanized as appropriate in accordance with the Specification. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electro-magnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc. which are built up of laminations or cannot for any other reasons be anti-rust treated, are to have all exposed parts thoroughly cleaned and heavily enamelled, lacquered or compounded.

The use of iron and steel is to be avoided in instruments and electrical relays whenever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be corrosion resisting steel. Instrument screws (except those forming part of a magnetic circuit) are to be of brass or bronze. Springs are to be of brass, bronze or other non-rusting material. Pivots and other parts for which non-ferrous material is unsuitable are to be of an approved stainless steel.

Fabrics, cork, paper and similar materials, which are not subsequently to be treated by impregnation, are to be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or linseed oil varnishes are not to be used.

21.5 Packing and Delivery

All plant and equipment as necessary shall be packed in first quality containers or packing; no second-hand timber shall be used. All packing must be suitable for several stages of handling via sea or air freight, inland transport and movement on site.

Flanged pipes are to have their open ends protected by adhesive tape or jointing and are then to be covered with a wooden blank flange secured by service bolts.

The sleeves and flanges of flexible couplings shall be bundled by wire ties. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 500 kg gross.

Precautions are to be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrappings impregnated with anti-rust composition or vapour phase inhibitors are to be used of sufficient strength to resist changing and indentation due to movement which is likely to occur in transit. The form of the protective wrappings and impregnation are to be suitable for a minimum period of twelve months.

Lids and internal cross battens of all packing cases are to be fixed by screws and not nails. Hoop metal bindings of cases are to be sealed where ends meet and if not of rustless material are to be painted. Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad. All stencil marks on the outside of the casing are to be either of a waterproof material or protected by Shellac or varnish to prevent obliteration in transit. Woodwool is to be avoided as far as possible. Waterproof paper and felt linings are to overlap at seams at least 12mm and the seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.

Where applicable, indoor items such as electric motors, switch and control gear, instruments and panels, machine components, etc. are to be 'cocooned' or covered in polythene sheeting, sealed at the joints and the enclosures provided internally with an approved desiccator.

Bright metal parts are to be covered before shipment with an approved protective compound or coating and protected adequately during transport to site. After erection these parts are to be cleaned by the Contractor.

Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forwarded to the Engineer; prior to despatch. All items of material are to be clearly marked for ready identification against the packing list. All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and to indicate the correct positions for slings, and are to bear an indelible identification mark relating them to the appropriate shipping documents.

The Engineer may require to inspect and approve the packing before the items are despatched but the Contractor is to be entirely responsible for ensuring that the packing is suitable for transit, and such inspection will not relieve the Contractor of any loss or damage due to faulty packing.

21.6 Workmanship

Workmanship and general finish shall be of first class commercial quality and in accordance with best practice. All covers, flanges and joints shall be properly faced, bored, fitted, fixed, hollowed, mounted or chamfered as the case may be, according to the best approved practice and all working parts of the plant and other apparatus, shall similarly be well and accurately fitted, finished, fixed and adjusted

21.7 Castings and Metals

All castings shall have an homogenous structure and be free from blowholes, flaws and cracks. Any casting having a thickness in parts in excess of 3 mm to that which it is purported to be shall be rejected. No repairs or patchwork to castings shall be allowed other than that approved by the Engineer.

Castings subject to hydraulic pressure shall be tested to 1.5 times the maximum working pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed.

Where not otherwise specified steel castings shall be selected from the appropriate grade. as per relevant IS.

All grey iron castings supplied shall be to the appropriate grade of IS:210. The Contractor shall replace any casting which the Engineer considers is not of first class appearance or is not in any way the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests. No plugging, filling, welding or "burning on" will be acceptable

All spheroidal graphite or modular graphite iron shall be to the appropriate grade of IS.1865.

Where not otherwise specified the bronze used shall be made of a strong and durable zinc free mixture as per relevant IS:318.

Aluminium and aluminium alloys shall not be utilised unless alternative materials are considered unacceptable. The use of aluminium requires the approval of the Engineer in all cases. Bars and extruded sections shall be as per relevant IS.

Aluminium and Aluminium Alloy Castings shall be manufactured as per IS:617:1994 and subjected to a chill cast to increase tensile strength. Immersed structures

or structures that are periodically immersed shall not be constructed from aluminium or aluminium alloys. All chromium plating shall comply with IS 1986.

21.8 Painting and Metal Protection

The surface preparation and painting or application of corrosion protection coatings to the following materials shall be carried out in accordance with relevant IS for the particular environmental conditions where the materials are used.

- Mild Steel
- Cast and Duct Iron
- Aluminium
- Nonferrous Parts
- Other small parts

21.9 Galvanising

Where steel or wrought iron is to be galvanised, it shall be carried out by the hot-dip process and shall conform in all respects with IS:2629. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanising.

All surface defects in the steel including cracks, surface laminations, laps and folds shall be removed in accordance with IS:6159. All drilling, cutting, welding, forming and final fabrications of unit members and assemblies shall be completed before the structures are galvanised. The surface of the steelwork to be galvanised shall be free from welding slag, paint, oil, grease, and similar contaminants. The articles shall be pickled in dilute sulphuric or hydrochloric acid, followed by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten Zinc and brushed, so that the whole of the metal shall be evenly covered and the additional weight thereof after dipping shall not be less than 610 grammes per square metre of surface galvanised, except in the case of tubes to BS.1387 when it shall be 460 grammes per square metre.

On removal from the galvanising bath the resultant coating shall be smooth, continuous, free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross. Edges shall be clean and surfaces bright. Bolts, nuts and washers shall be hot-dip galvanised and subsequently centrifuged in accordance with IS:2629. Nuts shall be tapped up to 0.4 mm. oversize before galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nuts.

During off-loading and erection the use of nylon slings shall be used. Galvanised work which is to be stored in Works or on Site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanised coating damaged in any way shall be restored by:-

- i. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
- ii. The application of two coats of zinc-rich paint (not less than 90 per cent zinc, dry film), or the application of a low melting-point zinc alloy repair rod or powder to the damaged area, which is heated at 300⁰C.
- iii. Fastenings of galvanised steelworks shall be hot dip galvanised and subsequently centrifuged in accordance with IS:2629. Nuts shall be tapped upto 0.4 mm oversize before galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nuts.
- iv. Where surfaces of galvanised steelwork are to be in contact with aggressive solutions and/or atmospheres the galvanising shall receive further protection by painting.

21.10 Fasteners

All bolts, nuts and studs with nominal diameters up to and Fasteners including 39mm required to be made in carbon steel shall conform to BS.6104 and threaded in accordance with IS:1367. Bright steel washers 3.0mm in thickness shall conform to BS.4320 and shall be provided beneath bolt head and nut. The above items required to be supplied in stainless steel shall conform to IS:1570. These items together with holding-down bolts and anchor plates required to be supplied in high tensile steel shall conform to BS.970 Ref. Symbol T Drilled anchor fixings for use on concrete structures shall be of a type Fasteners approved by the Engineer's Representative. The positions of all drilled anchors shall be approved by the Engineer's Representative and a Contractor proposing to use such fixings shall be deemed to have undertaken to supply, mark off, drill and fit. All exposed bolt heads and nuts shall be hexagonal and the length of all bolts shall be such, that when fitted and tightened down with a nut and washer, the threaded portion shall fill the nut and not protrude from the face thereof by more than a half diameter of the bolt. Rivets shall conform to BS.641 and tested in accordance with BS.1109.

21.11 Forgings

Carbon steel forgings shall be manufactured heat treated and tested in accordance with IS:2004-1991

21.12 Foundations and Setting of Machinery

The Contractor shall arrange for the provision of all foundations and plinths required for the plant and shall ensure that it is in accordance with the approved drawings. The Contractor shall provide all necessary templates for suspension of the holding-down bolts during grouting of same. The machinery shall be mounted on flat steel packings of a thickness selected to take up variations in the level of the concrete foundations.

The packings shall be bedded by chipping or grinding of the concrete surface. Only one packing of selected thickness shall be used at each location, which shall be adjacent to each holding down bolt. The number of shims shall not exceed two at each location and the thickness of each shim shall not exceed 3mm. The machinery shall be aligned, levelled and pulled down by the nuts of the holding down bolts with a spanner of normal length, and no grout shall be applied until the machinery has been run and approved by the Engineer for stability and vibration.

21.13 Bearings and Lubricators

The size of bearing shall be not less than that calculated for Bearings and a minimum L10 basic rating life in accordance with BS.5512 Lubricators Part 1., taking into account all considerations of reliability, materials of manufacture and operating conditions. All bearings shall be rated and sized to ensure satisfactory running without vibration under all conditions of operation for a minimum life of 50,000 hours running. They shall be efficiently lubricated and adequately protected from ingress of moisture, dust and sand and the particular climatic conditions prevalent at the site. All bearings shall be to ISO standard SI unit dimensions where practicable. All ball or roller bearings, except those supplied as "sealed for life" shall be arranged for grease gun lubrication and a suitable high pressure grease gun shall be supplied.

Adequate "Stauffer" screw top pressure grease lubricators with 'tell tale' stems or "Tat" grease nipples shall be provided for all moving parts. The position of all greasing and oiling points shall be arranged so as to be readily accessible for routine servicing. Where necessary, suitable access platforms shall be provided. The type of lubricant and intervals of lubrication, which shall be kept to a minimum (not less than nine days), for each individual item of plant shall be entered on a working schedule, which shall form part of the Operation and Maintenance instructions. A list of recommended Lubricants and their equivalents Bearings and shall be entered in the Operation and Maintenance instructions.

21.14 Labels

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items of plant. The reference numbers of all valves shall be as indicated on the schematic diagram to be supplied under the Contract. All warning labels shall comply with BS 5378 parts 1, 2 and 3 and of screw fixed rigid construction

Designation labels shall be of 5 mm Traffolyte with black lettering on white background. Embossed materials and techniques shall not be accepted.

The Contractor shall provide 2 No. enamelled iron plates worded "Men Working on Plant". The plates shall be 200mm x 75mm with red lettering on a white background. The Contractor shall also provide and fit warning labels for machinery that is operated under automatic control. All identification and warning labels shall be in English and in the local Language.

21.15 Guards

Adequate guards shall be supplied and installed throughout the installation to cover drive mechanisms. All rotating and reciprocating parts, drive belts, etc. shall be securely shrouded to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction they shall also be readily removable for gaining access to the plant without the need for first removing or displacing any major item of plant. The guards shall be of the open mesh type except where retention of fluid spray is required.

21.16 Suppression of Noise

All plant offered shall be quiet in operation. The noise levels in the entire premises shall be as per the norms of the Pollution Control Board. The noise levels measured as per IS/ISO:4412-1, 2 – 1991 shall be within the levels prescribed by TNPCB. The noise level within the building shall not be more than 85 decibels (+5 per cent on this over the audible frequency spectrum measured at mid-band.) "A" scale when measured along a contour 3 metres from any single item of plant during starting, running and stopping. The noise level outside the building shall not be more than 60 decibels (+5 per cent on this over the audible frequency spectrum measured at mid-band.) "A" scale when measured along a contour 3 metres from the external wall. Noise test measurements shall be made on completion of the installation of the plant at Site to verify that it complies with this Clause. Plant which fails to comply with the noise level limits when tested will render it liable for rejection unless it is satisfactorily modified at the Contractor's expense by the programmed commissioning date.

22. Submersible Sewage Pumps

The Contractor shall provide manufacturer's published pump curves, system curves and the necessary hydraulic calculations to justify the sizes of any pumps selected.

The Contractor shall provide the following shop drawings:

- impeller diameter
- maximum impeller diameter
- minimum impeller diameter
- velocity of liquid in pump suction at duty point
- velocity of liquid in pump delivery at duty point
- velocity of liquid in the pump casing or impeller eye at duty point
- net positive suction head (dry well submersibles only)
- the materials of construction shall be specified in detail and itemised against a sectional drawing of the pump proposed.

After approval of the pump types the Contractor shall submit the test data as required under factory inspection and testing

The Contractor shall submit Operation and Maintenance Manuals and Instructions which shall include all the documentation provided as above and as required in the Specification.

22.1 Pump Requirements

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range specified in the Specification without surging, cavitation, or excessive vibration to the limits specified. All pumps and drives shall be from approved manufacturers.

The pumps shall meet maximum allowable shut-off head.

The pumps shall not overload the motors for any point on the maximum pump speed performance characteristic curve and the pump operating range, within the limits of stable pump operation, as recommended by the manufacturer, to prevent surging, cavitation, and vibration.

To ensure vibration-free operation, all rotative components of each pumping unit shall be statically and dynamically balanced to IS:11723 Part 1 - 1992 and the following requirements shall be met:

- The mass of the unit and its distribution shall be such that resonance at normal operating speeds is within acceptable limits
- In any case, the amplitude of vibration as measured - at any point on the pumping unit shall not exceed the below limits
- At any operating speed, the ratio of rotational speed to the - critical speed of a unit, or components thereof, shall be less than 0.8 or more than 1.3.

Vibration levels shall not exceed the levels as per relevant IS.

The completed units, when assembled and operating, shall be free of cavitation, vibration, noise, and oil or water leaks over the range of operation.

All units shall be so constructed that dismantling and re-pairing can be accomplished without difficulty.

The Contractor shall be responsible for proper operation of the complete pumping system, which includes the pump, motor, variable speed drive unit (if designated), and associated controls furnished with the pump.

The Contractor shall ensure that the controls and starting equipment are suitable for use with the pump motor, taking into account all requirements including starting currents and number of starts per hour.

For the performance curve of the selected pump impeller, the head shall continuously rise as flow decreases throughout the entire curve from run out to shutoff head.

The Contractor shall ensure that drive motors, variable speed drive systems (if specified) and pumps shall be supplied and tested together by the pump manufacturer, who shall supply full certification for the proper function of the entire pumping system.

If variable speed drive systems are specified, motor and drive system shall be fully compatible, and shall be of sufficient power and torque, and be capable of sufficient heat transfer for starting, accelerating and continuously operating over the entire range of head/capacity conditions, from minimum to maximum pump operating speed, as designated. The motor shall be de-rated to take into consideration the reduced cooling effect when running at the lowest speed with the variable speed drive.

22.2 Design Conditions

Pumps shall be single stage mono-block type with nonclog design. It should pump all kinds of sewage in particular unscreened sewage containing long fibres, solid admixes, sludges, liquid containing trapped air and gas etc, long fibres, polythene covers, and capable of dealing with sewage of specific gravity 1.1

Profile gasket should be provided in pump casing so as to avoid metal to metal contact between pump and the special designed duckfoot bend/ flanged elbow, automatic coupling to ensure leak proof joint with delivery pipe. The profile of pumpside flange shall be matched with pump claw so as to automatically lock by virtue of its own weight or an automatic coupling device for easy installation and easy removal.

Pumps shall be designed and constructed to satisfactorily operate and perform within the designated design conditions and the requirements specified herein. They shall be designed for a life of 100,000 hours with service intervals at 20,000 hours.

Castings, fabrications, machined parts and drives shall conform to the industry standards for strength and durability and shall be rated for continuous duty over the entire operating range.

Bearings shall be of the anti-friction type designed for load and life in accordance with relevant IS according to the type of bearing used. The maximum operating speed shall not exceed 1450 / 960 rpm and shall be supplied as per BOQ.

Pumps shall be of non-clog design, capable of passing spheres of a size of 100mm diameter unless other diameters are specified. The pumpset shall be supplied along with special duckfoot bend / flanged elbow, lifting chain, guide wire / guide pipe.

Suitable RCC slab / ISMB (with necessary anti-corrosive painting) to be erected over suction well to fix guide wire / guide pipe holding bracket.

The pump, motor and associated electrical equipment shall be rated for a minimum 10 starts per hour, unless otherwise specified.

The Contractor shall ensure that the pump manufacturer provides certification which guarantees the following:

- flow rate
- total head
- power input
- efficiency

22.3 Materials

Pumps shall be manufactured of the following materials as a minimum:

- volute casings shall be cast iron, as per IS 210 Gr Fg 200 with 2 to 3 % Nickel. The internal surfaces shall be free of rough spots. The casing shall have center line discharge.
- impellers shall be stainless steel (CF8M).
- Pump shaft shall be of stainless steel (SS-410). The shaft shall be of one piece construction.
- motor casings shall be cast iron,
- shafts shall be stainless steel,
- fasteners shall be stainless steel,

The lifting system shall be manufactured of the following materials:

- the guide rail system shall be CI.
- lifting chains shall be MS-GLVD.

22.4 Fabrication

General. Pumps shall be fabricated in accordance with the following requirements:

- Pumps shall be capable of handling raw, unscreened sewage.
- in the case of submersible installations no portion of the pump shall bear directly on the floor of the wet well.
- pumps shall utilise a guide system to permit easy removal and reinstallation without dewatering the pump sump discharge connections shall be made automatically with a simple downward motion without rotation when the

pump is lowered into operating position. The pump shall be capable of being removed without disconnecting any fasteners

- an appropriate length of chain shall be connected to the motor eyebolts to permit raising and lowering of the pump.
- Impellers shall be fabricated according to the rated motor size as follows:
- non-clog type statically and dynamically balanced, keyed to the shaft
- provided with pump-out vanes to prevent material from getting behind the impeller and into mechanical seal area
- impellers shall not be trimmed unless approved by the Engineer. Provision for adjustment of clearance between impeller and casing for restoring the pump efficiency, without dismantling the pump will be an added advantage.
- single/multi vane or vortex type, with a cutter impeller in the case of small flows.

Discharge Connection and Guide Rails shall be fabricated as follows:

Sliding guide bracket and discharge connections shall be provided which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.

The guide rails shall not support any portion of the weight of the pump.

The pump discharge connections shall incorporate a sealing face and connection yoke to allow for automatic coupling to fixed discharge connection pipe work.

Pump Shafts shall be fabricated as follows:

- pump shafts shall be of such diameter that they will not deflect more than 0.05 mm measured at the mechanical seal, whilst operating at full driver output
- the shaft shall be turned, round and polished
- the shaft shall be key-seated for securing the impeller.

Shaft Seals shall be fabricated as follows :

- the drive motor and pump/motor bearings shall be sealed along the shaft with tandem mechanical seals operating in an oil filled chamber. The seals shall require neither routine maintenance nor adjustment, but shall be capable of being easily inspected and replaced.
- two back to back mechanical seals shall seal the motor off from the pump.
- the upper seal shall be oil lubricated with a carbon rotating component and fixed tungsten carbide component.
- the lower seal shall have both parts in tungsten carbide.
- a detector shall indicate when moisture is leaking past the first seal.

Bearings shall be fabricated as follows :

- bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump
- the upper bearing(s) shall be of the grease lubricated sealed for life type; the lower bearing(s) shall be lubricated by the internal oil supply
- the bottom bearing(s) shall be of the angular contact ball bearing type in combinations with roller bearing(s)
- if required in the project specification, remote indication shall be provided for bearing high temperature-, using a thermistor at the lower bearing, to provide a signal at 95 °C.

Motors shall be fabricated as follows :

- Motors shall be 415 V, phase, 50 Hz, rated at 10 % above the maximum power requirement
- Motors shall be squirrel cage, induction, air filled, totally sealed to IP 68, suitable for the maximum immersion depth to be encountered, rated for zone 2 use with group 1 gases, to BS 5345
- Motor insulation shall be Class F, limited to a Class B temperature rise
- Motor temperature shall be monitored using a thermistor, in each phase of the winding, set to stop the motor when the monitored absolute temperature reaches 130 °C
- A watertight cable junction box sealed from the motor shall be provided for the motor power and control cables shall be EPR insulated, Niplas sheathed flexible 450/750 volts grade, oil and grease resistant, with tinned annealed copper conductors in accordance with BS 6007. The cable shall be brought directly out of the submersible motor without joints, and shall be of sufficient length, minimum 20 m to be terminated in an IP67 junction box outside adjacent to the wet well. They shall be sized in accordance with the electricity utility regulations and BS 7671. The cable must be leak tight in respect of liquids and firmly attached to the terminal box. The should be laid in a suitable PVC encasing pipe from control panel upto suction well .
- Motors shall be capable of start up and operation in the event of a completely flooded wet well. Motors shall be selected to meet the maximum power required for the selected impeller at all operating conditions
- Motor cooling shall either be by means of the pumped medium or by oil. The use of external cooling water is not acceptable
- motors shall be derated for dry well and/or variable speed operation
- all parts of the pump and motor shall be 100% holiday free fusion bonded epoxy coated to a minimum thickness of 300 microns.

22.5 Control Panel

The control panel shall be made of 12 SWG (2.6mm) sheet steel for the front side and 14 SWG (2.0mm) sheet steel for bottom and other sides with powder coating for long life. It should have suitable starter. The control panel consists of multi section unit containing one pump and one incomer/control. The sections are interfaced, via, cable way/marshalling section. All wires and links are of electric grade copper conductor. The control of the pumps viz., Mercury/magnet activated/ any other float switch with auto for duty pump.

Power circuit is operating at 3 phase, 415 Volts, 50 Hz supply and for control circuit it is single phase 230 V, 50 Hz supply.

Type of starter shall be as under :

upto 10 HP - DOL

From 12 Hp to 40 HP - Star - Delta.

50 HP and above – Auto Transformer Starter / Soft Starter

The following protections should be provided in the panel: short circuit protection, over load protection, over temperature protection for motors, single phasing preventor, reverse rotation protection, dry run failure protections to be made. Suitable range ammeter, voltmeter, selector switch, auto-manual switch, pump running lamp, pump fault lamp, fault reset push button, phase indicating lamps, indication of high level in the well, hours run counter should also be provided.

The control panel wiring circuit should be furnished in triplicate.

The pump should be controlled by the magnetic/mercury float switches while the pumps run in auto. The floats with switches should be available in the wet wells and the connections from float should be made to the individual control panel through the cable duct. Necessary control sensor wiring should be made to convert the signals of mercury/magnet float switches while the level is high/low so that the pump starts/stops on automode.

The necessary push button stations with control wiring should be made on the wells for each pumpset each stations as per std. rules.

The control panel, pumpset and accessories for pumps should be manufactured by same manufacturer. The pump and motor shall be accordance with the relevant standards.

22.6 Automatic Control

The automatic level control shall be arranged such that when level rises in the well the pumps starts successively at the different pre-determined levels. When the level drops the pumpsets stop in the same order as that in which they have started. The

different start and stop levels for several pumps/single pump have to be chosen according to the sewerage and as desired by the Engineer. Magnetic/mercury float switches have to be used for this purpose.

The tenderer should also furnish the list of authorised dealers for the supply of spares for submersible pumps and list of authorised workshop to carry out repairs to the submersible pumps along with the address while tendering.

Labels. Each pump shall have a stainless steel label permanently fixed to the pump and an identical label fixed to the pump starter compartment.

22.7 Factory Inspection and Testing

The Contractor shall secure from the pump manufacturer certification that the following inspections and tests have been conducted on each pump at the factory, and submit to the Engineer prior to shipment:

- the pump casing has been tested hydrostatically to 1.5 times the maximum closed valve pressure
- impeller, motor rating and electrical connections checked for compliance with the Specifications
- motor and cable insulation tested for moisture content or insulation defects
- prior to submergence, the pump has been run dry to establish correct rotation and mechanical integrity
- the pump has been run for 30 minutes submerged under a minimum of 2 m water after the operational test and the insulation tests above and after the performance test below

Each pump shall be tested at the factory for performance according to BS 5316 Part 1, including:

- flow
- inlet pressure
- outlet pressure
- motor power
- torque
- efficiency

The Contractor shall secure from the pump manufacturer the following certification and submit to the Engineer prior to shipment:

- certified copies of the pump characteristic curves and reports generated by the tests described above

- foundry composition certificates for all major castings (pump case, impeller, motor housing) showing exact material composition and tests conducted to ensure compliance with the pump manufacturer's material specifications.

22.8 Site Inspection and Testing

The equipment delivered to the Site shall be examined by the Contractor to determine that it is in good condition and in conformance with the approved working drawings and certifications. All equipment shall be installed in strict conformance with the Specification and the manufacturer's instructions.

The Contractor shall provide the services of the pump manufacturer's representative to supervise the installation, commissioning and start-up of the pumping equipment.

The commissioning tests shall be performance and reliability trials, mainly for the purpose of satisfying the Engineer that the pumpsets have been correctly assembled and installed and that their performance matches that obtained during the manufacturer's works tests. In the event of an unwarranted change in the pump performance characteristics or power consumption, all necessary steps shall be taken as soon as possible to establish the cause and remove the fault. Similar action shall be taken for an undue increase in bearing or gland temperature, increased gland leakage rates, unsatisfactory vibration levels or any other fault or defect in the operation of the pumpset.

The site reliability trials shall include the following:

- A record of bearing and coupling clearance and alignments shall be tabulated to show the "as-built" condition of each pump
- A record of all overload, timing relay and oil pressure relays shall be tabulated to show the "as-built" condition of each motor starter
- All cables shall be 'megger' tested to confirm the integrity of the insulation. A tabulated record of results shall be made
- The control panel shall be statically tested with motors disconnected to confirm the correct sequence of operation
- Each pump shall be operated individually over the range from closed valve to maximum emergency top water level, on a recirculation basis, using fresh water, and for a minimum of four hours continuously. During this test the following parameters will be recorded: -
 - motor phase currents
 - pump output
 - ambient and test water temperatures
 - motor/pump casing temperature (dry well submersible only)
 - power consumed
 - power factor
 - vibration (dry well submersible only)

The commissioning trials shall extend until each pump unit has run 'continuously' for at least 3 days under all operating conditions. The term 'continuously' shall include running at various speeds or on a start/stop basis as determined by the control system

The Contractor's supervisory staff, and the pump manufacturers representative shall be present during the period of the tests and trials. The Contractor shall be responsible for any failure of the whole equipment or any part thereof, whether such failure shall be determined by the methods detailed herein or otherwise. If the Contractor interrupts the pump test or trial, or through negligence on the part of the Contractor's staff, it shall be completely repeated for the pumpset concerned.

22.9 Motors

All motors shall be suitable for operation on a 415v, 50 Hz, 3 phase, AC supply.

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions.

- | | | |
|-----|--|-----------|
| I | Variation of supply voltage from the rated motor voltage | : +/- 10% |
| ii | Variation of supply frequency from the rated frequency | : +/- 5% |
| iii | Combined voltage and frequency Variations | : +/- 10% |

All motors shall be capable of starting 6 times per hour. Starting current of motor shall not exceed 200% of the rated full load current for star - Delta starting and 600% of rated full load current for DOL Starting and also be limited below the maximum limit specified by the electricity supplying authority under any circumstances.

Motor shall be capable of starting and accelerating the load with the applicable method of starting without exceeding the acceptable winding temperatures, when the supply voltage is in the range of 10% above of the rated motor voltage.

Motor shall be designed to withstand 120% of the rated speed for two minutes without any mechanical damage in either direction or rotation.

The insulation class of motor windings shall conform to class - F and the maximum temperature rise shall not exceed 95⁰C, when measured by winding resistance method and 85⁰C, when measured by thermometer method for an ambient temperature of 45⁰C.

Motor shall be offered for routine and type tests in accordance with IS: 4029 and IS: 325 at the manufacturers works. Test certificates shall be endorsed to the effect that

they are properly balanced and free from vibration. In addition, a test shall be required to establish the maximum transient starting current.

Pump motors shall be of the squirrel cage submersible type, protected to IP. 58 and rated at 10 per cent above the calculated maximum power required on site.

The motor shaft shall be of large diameter, lightly stressed to ensure rigidity, with impeller and bearing location shoulders and a keyway for location of the impeller.

The motor windings shall be protected with a waterproof material and shall incorporate a thermistor in each phase to safeguard against high winding temperatures. The thermistor shall be connected into the control circuit of the starter and arranged for hand reset only.

The motor shall incorporate a cut-out device to detect the presence of any liquid in the motor enclosure.

The motor frame shall incorporate lifting points and shall be fitted with a galvanised lifting chain, reaching to, and secured at the access point.

The terminal connections for the power and protective circuits shall be housed in a completely sealed and waterproof junction box, complete with all external corrosion resistant cable glands.

The pump units shall be provided with power and protection circuit cables of sufficient length to reach from the motor junction box to the local isolator, located at the access level.

The power cable shall be 600/1000V grade flexible stranded copper wire, insulated and overall sheathed with under-water grade compound flexible insulation. The cables shall be rated to take the full motor current under the prevailing liquid and ambient temperature conditions.

22.10 Characteristic Curves

Characteristic and system curves for the pumps shall be supplied to a reasonably large scale which shall show the capacity of the pumps under single and multi pump operation at the duty point.

When tested through their complete range of workable heads at the maker's works, all the pumps shall give results which conform to the curves submitted with the Tender. Curves showing pump efficiency and kW. loading shall also be included.

22.11 Performance Test

Each pump shall be tested at the manufacturer's premises for the full operating range of the pump. Pump performance shall be within the tolerance limits specified in the relevant standards. The contractor shall furnish the guaranteed values of discharge and efficiency for the total head at duty point for each pump.

23. Diesel Generator

23.1 General

Electrical power supply for each pumping station will be availed from nearby TNEB supply point. According to the load requirement HT at 11kV or LT at 415 V - 3Phase will be availed from TNEB.

One Diesel driven alternator set of capacity as specified in the schedule of works shall be provided to permit operation of the Pumping Station in the event of failure of the TNEB electricity supply, complete with all equipment like Control gear, circuit breakers, cabling, synchronising equipment etc. The DG Set shall conform to latest version of IS:13364 - 1992.

The Contractor shall also make his own calculations with regard to the rating of the generating set(s), which shall each be large enough to start and run the smaller capacity sewage pump(s) (not the grit pump) and withstand other essential load along with lighting load but which shall not be less than that stated in the schedule, at a power factor of 0.8. The de-rating factors corresponding to the temperature, humidity and pressure should be considered. The continuous rating of the motors shall be used to calculate the maximum demand.

A 10 per cent margin of the capacity of the total load shall be allowed for contingencies and spare capacity.

The engine alternator sets shall be designed such that the starting power peak shall not exceed 10 per cent of the continuous engine rating and the voltage dip shall not exceed 15 per cent whilst starting the connected load under the worst conditions.

The Contract Drawings show the building, floors and other details as they will be constructed and the space allocated for the generating plant, control gear and circuit breakers. If any departures from the proposed layout are necessary, the Contractor shall show the modifications required on the drawings, and shall call the Engineer's attention to these proposed alterations.

Contractor's attention is specifically drawn to the operating conditions whereby generator sets could be running at little or no load due to the intermittent and differing

flow rates and pump capacities. The diesel generator shall be capable of working at safe minimum working levels.

The D.G. Set shall be enclosed in a acoustic enclosure and the noise levels while operation shall be restricted to the levels as per the Pollution Control Board Norms.

23.2 Detailed Description of Generator Engine

Each engine shall be four stroke, naturally aspirated or pressure charged, water-cooled, vertical diesel type, of the airless injection principle with all cylinders and valve gear totally enclosed.

Each engine shall run at a speed not exceeding 1500 rpm. and be suitable for remote operation provided with forced feed lubrication to all working parts including the camshaft, rocker gear, valve guides etc. A strainer shall be located in a suitable position in each system. The whole of the lubricating oil shall be cooled by means of an inter-cooler situated adjacent to the engine with circulating water dissipating the heat taken from the oil. The necessary circulating pumps shall be provided which shall be integral with the engine together with all the appropriate pipework and appurtenances. Individual flow indicators shall be provided for the jacket and lubricating oil circuits.

A sensitive Class A2 governor or a superior type shall be incorporated and this shall be capable of maintaining a constant speed under all conditions of load. Motor operated speed regulating gear shall be provided to enable the speed of the engine to be varied by 5 per cent up or down from normal speed while in operation. The remote control for this regulating gear is to be operated from the switchboard.

Over-speed protection shall be provided so that in the event of the engine speed exceeding 10 per cent above the maximum operating speed an audible warning and indicator light shall be brought into operation, but should the speed still continue to rise to a figure of 15 per cent above normal speed the fuel supply shall be automatically cut off and the engine brought to rest. The audible warning and indicator light, together with the other indicating lights and alarms specified hereafter, shall indicate on the monitoring panel in the alternator switchboard.

A heavy type of flywheel shall be provided so that there will be a minimum of cyclic irregularity throughout the working range of the engine. Distortion or vibration and oscillation of the crankshaft shall be obviated under all normal working conditions.

The crankshaft shall be of solid forged steel statically and dynamically balanced to very close limits. Hand operated barring gear shall be provided for each engine.

Aspiration air filters shall be mounted directly on each engine and shall be of the heavy duty type, suitable for a sand laden atmosphere.

Protected thermometers in suitable pockets shall be provided for measuring the temperature of the inlet and outlet cooling ion water and lubricating oil. Each engine shall be provided with a temperature indicator on each exhaust branch. Lubricating oil and circulating water pressure gauges shall be provided on the local panel.

A positive driven tachometer and hours counter shall be provided and fixed in a convenient place on each engine and the tachometer shall be connected to an engine speed indicator mounted on a local panel to be mounted on each engine.

In addition to the over-speed alarm, protection devices shall be provided in the lubricating oil circuits and cooling water circuits to operate alarms and indicator lights, in the event of abnormal running conditions prevailing. These lights shall indicate on the remote monitoring panel. The engine shall shut down under alarm conditions.

The whole of the design, rating and testing of each engine shall be in accordance with IS:13364 for solid injection liquid fuel engines.

Each engine shall be designed to operate with an ambient air temperature of 45⁰C and be capable of satisfactorily providing an output 10 per cent in excess of the BHP rating at the same speed for any one hour in the duration of 12 hours of consecutive operation.

Each engine with flywheel and alternator shall be mounted and aligned on a common under bed. Anti-vibration mountings shall be provided between the under bed and the concrete foundation. Each cylinder shall have renewable wet liners, and be fitted with individual cylinder heads. Wet liners shall be treated on the water jacket side with a rust inhibitor. Immersion heaters and thermostat control shall be incorporated in each engine oil sump and water jacket to ensure rapid warm up on starting.

Each engine shall be provided with an oil drip tray complete with plugged outlet. The engine shall be painted in accordance with the Manufacturer's recommendations, color finish as advised by the Engineer.

23.3 Engine Cooling Equipment

Each engine shall be cooled by a bed-plate mounted tropical rated radiator and cooling fan, adequately rated to maintain the normal working temperature, under continuous, full load operation, working in conjunction with a pressurized water system, thermostatically controlled with centrifugal water circulating pump, valves and pipework.

23.4 Exhaust System

A complete engine exhaust system shall be provided for each engine and shall incorporate a highly efficient residential quality silencer, expansion box, tubular lengths of exhaust piping and all necessary flexible connections to lead the exhaust fumes to the open atmosphere as per the recommendations of TNPCB.

The exhaust piping shall be adequately lagged and clad within the station with polished aluminum sheeting. All the necessary supports shall be included. Closing plates to apertures in walls shall also be provided. Very special attention shall be paid to the preparation and protection of the exhaust system.

23.5 Bed-plates and Couplings

A rigidly constructed, fabricated steel combined bed-plate shall be provided for each generator set to withstand the weight and shall be suitably machined on top for the reception of the engine and alternator. The bed-plate design shall incorporate anti-vibration mountings to provide complete isolation of vibration from the concrete foundations.

Each alternator shall be directly coupled to its associated engine by means of an adequately rated, flexible, multi-pin, balanced coupling in accordance with section 3 securely keyed to the shaft or close coupled to the engine. Each coupling, flywheel and any other moving part on the generator set shall be fitted with close mesh guards which shall allow access to all greasing and lubrication points. Guards shall be readily removable for maintenance purposes.

23.6 Enclosure of the DG Set

The entire assembly of engine, alternator and controlling equipment shall be housed in an acoustic enclosure as per the notification of the Pollution Control Board. The noise level of the DG Set shall be limited to the prescribed levels as per by the PCB. The enclosure shall be suitable for outdoor erection with relevant IP.

23.7 Starting Equipment

Each of the generator sets shall be started by means of a heavy duty, axial, starter motor, fitted with automatic disengaging mechanism on engine start-up, operating in conjunction with a 24 volt battery panel, installed locally to each generator set.

Batteries shall be of the heavy duty, 24 volt, sealed maintenance free lead acid, and be complete with charger, housing cabinet and necessary interconnecting cable. The capacity of each battery set shall allow for not less than 10 consecutive starts, each of 15 second duration.

Each battery charger shall be connected to the main motor control centre board in the control room.

The first charging of the batteries shall be carried out as per the recommendations of the manufacturer with a suitable battery charger.

23.8 Detailed Description of Alternators

The alternators shall be continuously rated for continuous operation and generate at 415volts, 3 phase 50Hz., with the neutral point connected to a common earth bed. The alternator neutral contactor shall be closed when the alternator is running.

The alternator enclosures shall be protected to IP.23. They shall be suitable in all respects for operating in the climate as detailed elsewhere.

The alternator excitation equipment shall be of the quick response self-exciting, self regulating brush-less type, suitable for starting the motors.

The insulation of the stator and rotor shall be in accordance with British Standard Class 'F' but the alternator shall be designed for a Class 'E' temperature rise. The efficiencies of the alternator shall be stated in the Schedules and shall be determined in conformity with the procedure laid down in IS:269 and shall be manufactured in accordance with BS.2613.

Each alternator shall be capable of satisfactorily providing an output 10 per cent in excess of the BS rating for one hour in any period of 12 hours' consecutive running.

The rotating parts shall be statically and dynamically balanced to close limits.

Each alternator shall be fitted with anti-condensation heaters of a size to maintain the temperature of the windings 5° above ambient. Each heater shall be provided with a switch and automatic control to disconnect the heater when the alternator is running.

Terminal boxes shall be provided and arranged with sealing chambers for the reception of the cables detailed in the relevant sections of the Specification. Terminals shall be clearly marked to give phase identification.

The alternator shall be painted in accordance with Manufacturer's recommendations, finished colour as instructed by the Engineer.

23.9 Daily Storage Tanks

Each engine shall be provided with a free standing daily tank of sufficient capacity to allow 12 hours of continuous operation at full load. For permanent mounted sets each daily tank shall be provided with the following fittings:-

- Air vent of not less than 50mm. diameter.
- Overflow piping of not less than 150 per cent diameter of the Fuel Delivery line.
- Cleaning hand hole and cover of not less than 300mm. diameter.
- Contents gauge graduated in Tamil and English to read "Full - 1/2 Full - Empty". The gauge shall be of the magnetically operated type and shall be complete with low and high level control contacts

- Outlet connection to engine not less than 50mm. above tank base
- Fuel outlet isolating valve lockable in open position
- Drain plug
- Excess fuel return connection.
- Inlet connection from bulk fuel supply system including pipework and connections.
- There shall be allowed a minimum of 5 per cent of the volume of the tank contents as sullage. The top oil level of the tank shall not be less than 75mm from top of the tank.
- Tanks prior to dispatch from manufacturers works shall be tested hydraulically to a pressure 0.5 bars.
- Daily tanks shall be complete with all supports and fixing bolts for mounting remote from engine. Base or skid mounted tanks will not be accepted.
- There shall be provided all necessary fuel oil pipework, unions and valves between the day tank and the engine.
- Fuel connecting pipework to engine shall be seamless steel and all pipes shall incorporate flexible section if not less than 250mm. long (plastic pipes or fittings are not acceptable).

23.10 Warning and Safety Notices

The following warning notice shall be supplied and fixed in a prominent position in the vicinity of each bulk fuel tank with 50mm. plain block black letters on a yellow background, printed in Tamil and English.

**NO SMOKING
DIESEL FUEL - HIGHLY INFLAMMABLE**

Additional notices shall be provided is required. The wording of the notices shall be subject to the Engineer 's approval.

23.11 Performance Requirement

The diesel generator and accessories shall be so designed as to meet the following performance requirements:

- The unit shall be capable of starting from cold condition, reaching operating speed and taking up load within the shortest possible period.
- The unit shall be capable of delivering continuously at the generator terminals a net output specified. This net output shall be obtained after necessary derating of engine due to site conditions

and unit auxiliary power requirements have been taken into consideration.

- The unit shall be capable of a peak output of 10% in excess of the rated output for a period of one hour out of a total of twelve consecutive hours of operation, without exceeding permissible temperature limits and with a fairly visible exhaust.
- The unit shall be continuously rated to supply power for the periods.

The following items of performance shall be guaranteed during site performance tests by the supplier in respect of the diesel generator and the auxiliary for the specified site conditions:

- Net electrical output
- Fuel oil consumption at 1/2, 3/4 and full load
- Jacket water temperature to and from engine
- Lubricating oil temperature to and from engine
- 10% overload for one hour out of a total of twelve consecutive hours of operation without overheating or showing signs of undue stress and within specified frequency variations
- Freedom from vibration and noise
- Governor response, overspeed trip and speed gear capability
- Voltage regulator response
- Excitation at full load and under specified variation of voltage and speed

Window type annunciators shall be supplied and mounted on generator control panel to give visual and audible indication for the following conditions.

- High jacket cooling water temperature
- High lubricating oil temperature
- Low lubricating oil pressure
- Low fuel oil tank level
- Engine overspeed and trip
- Over current
- Earth fault
- Contactor on & off indication
- Voltage out of limit
- Excitation failure
- Generator fault

23.12 Drawings And Data

The BIDDER shall furnish the following drawings/data in the Technical Bid.

- Control panel dimensions and drawing showing plan, front view, foundation details, inside view, terminal block location etc.
- Schematic diagrams of the electrical circuitry
- General arrangement of the complete DG Set.

23.13 Testing and Commissioning

The supplier shall perform all the standard shop tests to ensure that the equipment conforms to the specifications and meets the performance guarantees.

The installation / commissioning of the D. G set shall be as per the applicable code of practice and the MANUFACTURER'S instructions.

PREFERRED MANUFACTURERS

The bidder's can use equivalent makes provided its quality on par with preferred Makes.

Table - I

Sr. No	Item Man	ufacturers
1.	Pumps (submersible, dry pit & grit)	KSB / KISHOR / GRUNDFOS/ (AQUA upto 100 HP)
2.	Metering equipments like C.T.P.T. and Trivectometer	GYRO/ IMP/ GEC/ UNIVERSAL / SIMCO / HPL SOCOMEC / HAVELLS
3.	Switch & Fuse Unit	SIEMENS/ L & T/ JYOTI / GEC/ ELECTRIC CONTROL GEARS PVT. LTD., / CROMPTON GREAVES, CONTROLS & SWITCH GEAR / STANDARD/HPL
4.	L.T. & Control Cables	CCI, ICC, ASIAN, GLOSTER, UNIVERSAL., OMEGA, HAVELLS/HPL
5.	Cables (660 V Grade)	ASIAN/ UNIVERSAL/ GLOSTER/ TROPODUR/ FINOLEX/ INDIAN CABLES/ INDUSTRIAL CABLES, HAVELLS /HPL
6.	PVC Insulated Cu.wire	PHILCO or SANDEEP /HPL
7.	H.G. Conduit Pipes	NATIONAL/ KHANDELWAL/ SUPREME/ ECW.
8.	L.T. Panel Board	GEC/ JYOTI/ SIEMENS/ KIRLOSKAR ELECTRIC/ EASUN/ CROMPTON GREAVES / POWER TECH / ENPRO ENGINEERING / SPACE AGE SWITCHGEAR
9.	Capacitors L.T.	JUNKER/ CROMPTON/ VOLTAS/ MADHAV/ HICCO/ENERGY CAPACITORS / HAVELLS.
10.	Electrical Motors,	ABB / KIRLOSKAR/ JYOTI/ NGEF/ SIEMENS/ AEC/ BHARAT BIJLEE/ CROMPTON/ BHEL
11.	D.O.L. and Star Delta Starter.	L.T./ LK/ SIEMENS/ CUTLER HAMMER/ CROMPTON GREAVES.
12.	Switchgear with HRC Fuses	ENGLISH ELECTRIC/ SIEMENS/ L&T/ JYOTI/ SYSTEM CONTROLS/ HAVELLS /HPL
13.	ACB/M.C.C.B./MCB	ENGLISH ELECTRIC/ CROMPTON/ L & T/ STANDARD/ C AND S LTD / ANDREW-YULE SPACEAGE / SWITCHGEAR/ HAVELLS/HPL

Sr. No	Item Man	ufacturers
14.	MCB Distribution Board	MDS/LOADSTER & LOADKONTAKT/STANDARD/HPL
15.	PVC 5A and 15A Switches	ANCHOR/ PRECISION/ MK/ CPL
20.	PVC 5A and 15A Sockets	ANCHOR/ PRECISION/ MK/ CPL
21	D.G.SET ENGINE	KIRLOSKAR / ASHOK LEYLAND / CATER PILLAR / CUMMINS
22	ALTERNATOR	KEC / NGEF / CROMPTON / JYOTHI
23.	GLS/ H PSV/ H PMV/ Flourescent Tubes/ other type lamps.	Philips / Crompton / Bajaj Mysore Lamps / Sylvania-hazman / Osram / WIPRO/ HAVELLS
24.	Luminaires	Philips / Crompton / Bajaj Lumex, GEC/ WIPRO/ HAVELLS/HPL
25.	Ceiling / Exhaust / FANS Air Circulators.	Crompton / Bajaj/ Khaitan Polar / Rallis / Almonard Orient / Usha/ HAVELLS.
26.	Switches, SFV	Anchor / Radart / Khosla / Vinay / Pointer / MK / CPL.
27.	Emergency Lights	Prolite / Elite / Instalite.
28.	PVC Power and control cables, Flexible and house wiring cables.	Universal / Asian / Finnolex / Torrent / Uniflex / Tropodor / Jhonson / HMT Cable corporation / OMEGA/HPL
29.	Steel Tubular poles; caps and brackets	ITC,RUBIT,UNIFAB, B.T. & P. Co.
30.	Electro mechanical valve actuators, Valves, Dampers	MARSH
31.	HT Switchgear - VCB, RMG, Unitised Substation, Load Break Switch, LA, CT, PT, HRC Fuses	SEIMENSES / BIECCO LAWRIE LTD/ CONTROLS & SWITCH GEAR / ESWARI ELECTRICALS

Schedule of Particulars

General Notes

At the time of bidding, the Bidder is required to furnish the relevant details for each pumping station with respect to all the plant and equipment proposed to be installed as required in the schedule- I below and to be annexed with BOQ.

Particulars given in these Schedules will be binding on the Contractor and may not be varied, except with the consent in writing of the Engineer. The approval or otherwise of the particulars given, shall be deemed in no way to relieve the Contractor of any of his obligations under the Contract.

The Contractor shall supply, install and connect all cables for the installation of the equipment included in these Schedules. The sizes of these cables will be determined by the contractor and be subject to approval by the Engineer.

The Contractor shall be responsible for accurately estimating length and rating of all cables, in accordance with the Specification.

The Contractor will be required to furnish a comprehensive schedule of all cables showing core numbers, termination numbers etc. for approval.

SCHEDULE - I

S.No.	Description	Unit
	Pumping Station -	
	Submersible pumps	
1	Manufacturer	
2	Model No.	
3	Net positive Suction head required	m
4	Maximum flow	lps
5	Total head at Maximum flow rate	m
6	Guaranteed efficiency of pump at duty point	%
7	Impeller size	mm
8	Solid handling capacity	mm
9	Full load current	Amp
10	Motor speed	rpm
11	Thermistor fitted	Y/N
12	Cable length attached (minimum 10 m)	m
13	Material: a - Casing b - Impeller c - Shaft	
14	Continuous Motor rating	KW
15	Type of thrust bearing Type of journal bearing	
16	Pump Performance Curves supplied (Q vs H, P, n & NPSH)	Y/N

Description	Unit
Pumping Station -	
Bus Bars	
Material	
Cross section	mm
Continuous current rating	Amp
Type of insulation	
Current Transformer	
Make	
Type	
C T Ratio	
Voltage Transformer	
Make	
Type	
Ratio	
Over voltage vector	
Power Capacitor	
Make	
Type	
Capacity of the Bank	kVAR/MF
Capacitor element	
Type of insulation used	
Automatic power factor correction unit installed	Y/N

CHAPTER 18 - ABBREVIATIONS AND ACRONYMS

S.W S	toneware
C.I. C	cast Iron
C.M. C	Cement Mortar
Cm Centi	metre
CMWSSB	Chennai Metropolitan Water Supply & Sewerage Board
Cum C	Cubic metre
Dia. Di	Diameter
D.I. D	Ductile Iron
Km Ki	Kilometre
M.H. Manh	Manhole
M.S. Mil	Mild steel
m Met	metre
mm M	millimetre
R.C.C.	Reinforced Cement Concrete
sq.cm S	square centimeter
W.C. (ratio)	Water Cement (ratio)

APPENDIX – BORE LOG DETAILS

NEO GEOCONS

Bore Log & Laboratory Test Results

TABLE – 1

Client: M/s Consulting Engineering Services (India) Pvt; Ltd;
M.R.C. Nagar, Chennai.

Project: Construction of Sewerage scheme for Ullagaram – Puzhuthivakkam
Town Panchayat, Chennai.

Bore Hole No : 1

Ground Water Level: 0.50m depth
(During January 2003)

Bore Hole Location : Near Burial Ground

Depth (m)	Soil profile	Description	Gradation				Classification	SPT N value	SPT depth (m)
			G %	S %	SI %	CL %			
1		Top soil fill materials 0 – 1.80m	-	-	-	-	-	-	-
2		Graysih brown gravelly clayey silty sand 1.80 – 3.50m	8	68	13	7	SC	19	2.00
3			5	22	23	0	SM	28	3.50
4		Grayish fully weathered soft disintegrated rock 3.50 – 7.50m	17	65	18	0	SM	> 100 (50 for 12cm)	5.00
5			2	78	20	0	SM	> 100 (50 for 6cm)	7.50
6		Grayish fully weathered rock 7.50 – 10.0m	-	-	-	-	-	> 100 (Rebound)	10.00
7			-	-	-	-	-	-	-
8		Highly weathered rock 10m below	-	-	-	-	-	-	-
9			-	-	-	-	-	-	-
10									
11									

G: Gravel,

S: Sand,

SI: Silt,

CL: Clay

B-4D

NEO GEOCONS

Bore Log & Laboratory Test Results

TABLE - 2

Client: M/s Consulting Engineering Services (India) Pvt; Ltd;
M.R.C. Nagar, Chennai.

Project: Construction of Sewerage scheme for Ullagaram – Puzhuthivakkam
Town Panchayat, Chennai.

Bore Hole No: 2

Bore Hole Location: AGS Colony

Ground Water Level: 3.0m depth (During January 2003)

Depth (m)	Soil profile	Description	Gradation				Classification	SPT N value	SPT depth (m)
			G %	S %	SI %	CL %			
1		Top Soil Greyish Brown clayey silty sand 0 – 1.0m	1	56	31	12	SC	-	-
2		Brownish Grey clayey silty sand 1.0m to 3.30m	0	67	20	13	SC	7	1.50
3			1	65	19	15	SC	10	2.50
4		Brown Soft Disintegrated Rock 3.30 to 7.0m	15	52	33	0	-	>100 (50 for 8 cm)	3.50
5			25	53	22	0	-	> 100 (50 for 7 cm)	4.50
6			42	38	10	0	-	> 100 (50 for 8 cm)	7.00
7									

G: Gravel,

S: Sand,

SI: Silt,

CL: Clay

NEO GEOCONS

Bore Log & Laboratory Test Results

TABLE - 3

Client: M/s Consulting Engineering Services (India) Pvt; Ltd;
M.R.C. Nagar, Chennai.

Project: Construction of Sewerage scheme for Ullagaram – Puzhuthivakkam
Town Panchayat, Chennai.

Bore Hole No: 3

Bore Hole Location: Sreenivasa Nagar.

Ground Water Level: 3.50m depth (During January 2003)

Depth (m)	Soil profile	Description	Gradation				Classification	SPT N value	SPT depth (m)
			G %	S %	SI %	CL %			
1		Top soil fill (Rubbish) 0 – 0.60m	-	-	-	-	-	-	-
2		Brown Sandy Silty Clay 0.60 – 2.20m	0	30	32	38	SC	7	1.50
3		Greyish Brown Clayey Silty Sand with Gravel 2.20 – 3.20m	20	41	21	18	GM/SC - SM	12	2.50
4			22	62	14	0		-	47
5		Brown Soft Disintegrated Rock 3.20 – 7.00m	12	78	10	0	-	>100 (50 for 9 cm)	4.50
6								> 100 (50 for 6cm)	
7			28	64	8	0	-		7.00

G: Gravel,

S: Sand,

SI: Silt,

CL: Clay

B-4²

NEO GEOCONS

Bore Log & Laboratory Test Results

TABLE - 4

Client: M/s Consulting Engineering Services (India) Pvt; Ltd;
M.R.C. Nagar, Chennai.

Project: Construction of Sewerage scheme for Ullagaram – Puzhuthivakkam
Town Panchayat, Chennai.

Bore Hole No: 4

Bore Hole Location: Bajana Koil Street.

Ground Water Level: 4.0m depth (During January 2003)

Depth (m)	Soil profile	Description	Gradation				Classification	SPT N value	SPT depth (m)
			G %	S %	SI %	CL %			
1		Top soil Brown silty sand 0 – 0.75m	1	70	29	0	SM	-	-
2		Yellowish Brown Soft Disintegrated Rock	4	63	33	0	SM	21	1.50
3		comprising of silt & sand 0.75 – 3.25m	2	66	32	0	SM	26	2.50
4		Grayish Brown Soft Disintegrated Rock 3.25 – 6.00m	16	67	17	0	-	> 100 (50 for 11 cm)	3.50
5			23	58	19	0	-	> 100 (50 for 7 cm)	4.50
6		Grayish Highly Weathered Rock 6.00 – 7.00m	72	24	4	0	-	> 100 (50 for 5 cm)	7.00

G: Gravel,

S: Sand,

SI: Silt,

CL: Clay

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NEO GEOCONS

Bore Log & Laboratory Test Results TABLE - 5

Client: M/s Consulting Engineering Services (India) Pvt; Ltd;
M.R.C. Nagar, Chennai.

Project: Construction of Sewerage scheme for Ullagaram – Puzhuthivakkam
Town Panchayat, Chennai.

Bore Hole No: 5

Bore Hole Location: Eswaran Koil Street.

Ground Water Level: 2.50m depth (During January 2003)

Depth (m)	Soil profile	Description	Gradation				Classification	SPT N value	SPT depth (m)
			G %	S %	SI %	CL %			
1		Top soil Fill Grayish Brown Clayey Silty Sand 0 – 0.50m	10	60	20	10	SC	-	-
2		Brown Silty Sand 0.50 – 3.30m	5	67	28	0	SM	38	1.50
3			2	72	26	0	SM	42	2.50
4		Grayish Brown Soft Disintegrated rock 3.30 – 5.50m	15	65	20	0	-	> 100 (50 for 8cm)	3.50
5			14	68	18	0	-	> 100 (50 for 6 cm)	4.50
6			Grey Partly weathered rock 5.50 – 7.0m	-	-	-	-	> 100 (rebo und)	7.00

G: Gravel,

S: Sand,

SI: Silt,

CL: Clay

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BORE LOG & GRAIN SIZE ANALYSIS
TABLE - 5

Project : Design for laying of Sewerage pipes for the proposed underground Sewerage Drainage Scheme at Ullagaragam Town Panchayat (Sew. System).

Bore Hole No. 6

Location : Sivaprakash Nagar Main Road, House No.5 (Right side)

G.W.L. : Not encountered

Depth (m)	Soil Profile	Description	Grain size Analysis			
			G%	S%	Si%	CL%
0 - 1.50		Top Soil grey clayey silty Sand	0	63	-37-	
1.50 - 2.10		Brownish Grey Calcareous Clayey Silty sand with Little Kankar	1	60	-39-	
2.10 - 2.60		Brown silty sand	1	61	38	0
2.60 - 3.0		Brown SDR	6	65	-29-	
3.0 below		Hard Stratum Highly Weathered rock SPT 'N' value > 100 (50 for 7cm) Rebound	-	-	-	-

- G = Gravel
- S = Sand
- Si = Silt
- Cl = Clay

G.W.L = Ground water level during September 2001.

SDR = Soft Disintegrated rock

**BORE LOG & GRAIN SIZE ANALYSIS
TABLE - 7**

Project : Design for laying of Sewerage pipes for the proposed underground Sewerage Drainage Scheme at Ullagaragam Town Panchayat (Sew. System).

Bore Hole No. 7

Location : Ram Nagar 4th Street, House No. 6 (Right Side)

G.W.L. : 0.50m

Depth (m)	Soil Profile	Description	Grain size Analysis			
			G%	S%	SI%	CL%
0 – 2.60m		Top Soil Brown Sandy silty clay	0	25	28	47
2.60 – 4.70m		Greyish Brown SDR Compressing of silty Sand	7	53	-	40
4.70 below		Hard Stratum Highly Weathered rock SPT 'N' value > 100 (50 for 4cm) Rebound	-	-	-	-

- G = Gravel
- S = Sand
- Si = Silt
- Cl = Clay

G.W.L = Ground water level during September 2001.

SDR = Soft Disintegrated rock




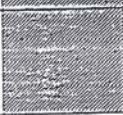
**BORE LOG & GRAIN SIZE ANALYSIS
TABLE - 8**

Project : Design for laying of Sewerage pipes for the proposed underground Sewerage Drainage Scheme at Ullagaragam Town Panchayat (Sew. System).

Bore Hole No. 8

Location : Sheela Nagar Main Road, House No.2 (Right side)

G.W.L. : Not encountered

Depth (m)	Soil Profile	Description	Grain size Analysis			
			G%	S%	Si%	CL%
0 – 0.60m		Brown Silty sand	2	80	18	0
0.60 – 2.30m		Brown silty sand with Little gravel	5	75	-20-	
2.30m – 3.20m		Dark Brown SDR	5	62	-33-	
3.20m below		Hard Stratum Highly Weathered rock SPT 'N' > 100 (50 for 11cm)	-	-	-	-

- G = Gravel
- S = Sand
- Si = Silt
- Cl = Clay

G.W.L = Ground water level during September 2001.

SDR = Soft Disintegrated rock

